Subgrouping patients with low back pain

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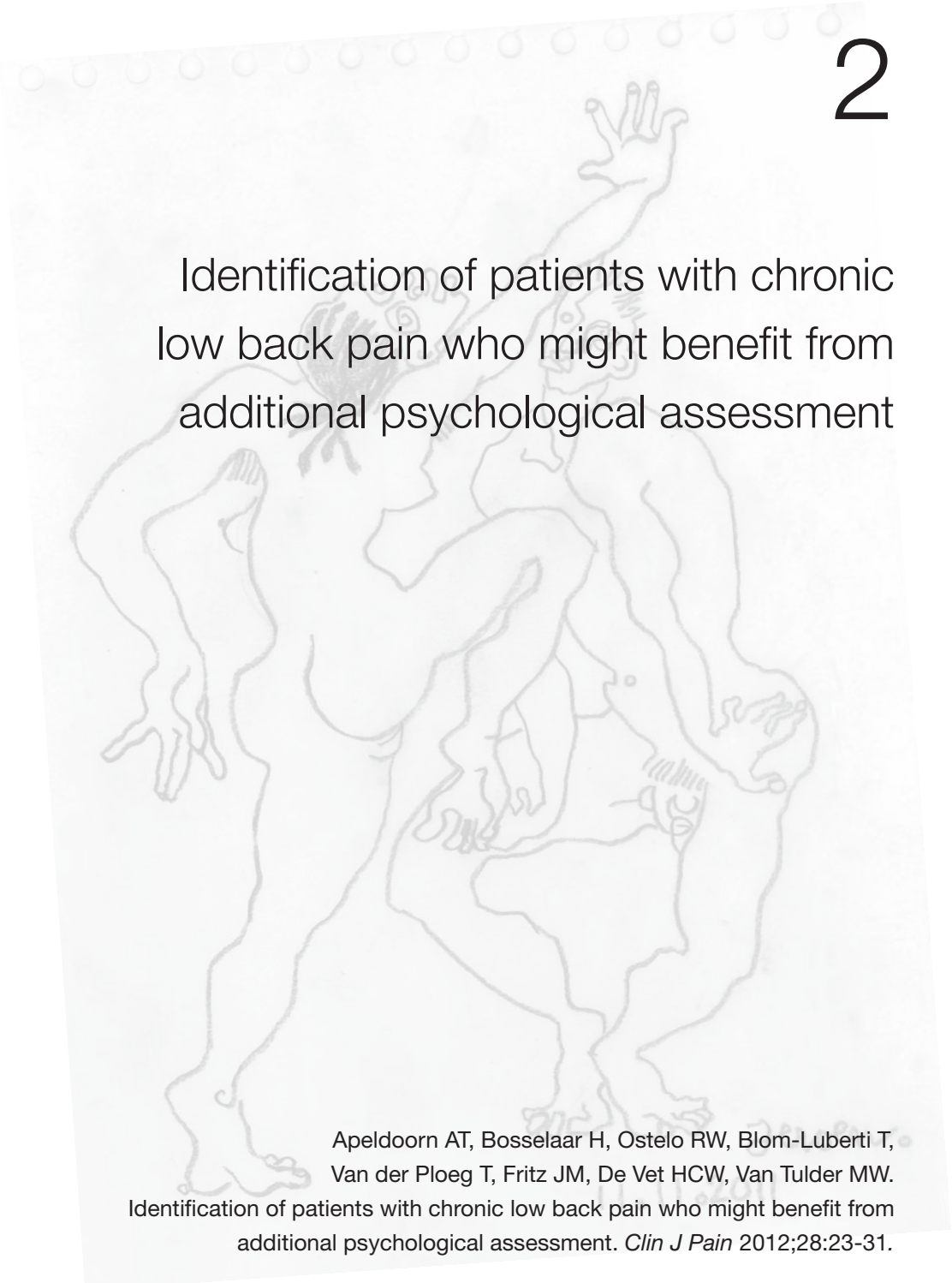
Identification of patients with chronic low back pain who might benefit from additional psychological assessment



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Abstract

Objectives: To identify signs and symptoms that should alert clinicians to the need for additional psychological assessment in patients with chronic low back pain (CLBP).

Methods: In this prospective cohort study, 229 consecutive patients with CLBP who attended an outpatient rehabilitation centre were assessed by psychologists and physical therapists before their treatment started. The signs and symptoms assessed by the physical therapists were compared with the assessments made by the psychologists, which were considered to be the reference standard (relevant psychological disturbances, yes or no). Univariable and multivariable regression methods were applied to investigate which signs and symptoms were associated with the reference standard. A receiver operator characteristic (ROC) curve was constructed to assess the overall accuracy of the final model.

Results: The psychologists classified 53% of the patients as having relevant psychological disturbances. Univariable analysis revealed statistically significant differences ($p < 0.05$) between the two patient groups (relevant psychological disturbances yes or no) for 10 of the 17 signs and symptoms. Multivariable analysis yielded a screening instrument consisting of the following four signs and symptoms: presence of Waddell signs, elevated scores on the pain drawing, absence of a directional preference, and daily use of analgesic medication for CLBP (area under the ROC curve 0.81 [95% confidence interval 0.75 to 0.87]).

Discussion: This study established a clinically useful screening instrument for the identification of patients with CLBP who might benefit from additional psychological assessment in an outpatient rehabilitation setting. Further research is needed to confirm our preliminary results.

Introduction

It is generally recognized that biological, psychological, and social factors play an important role in the development and persistence of low back pain (LBP).[1,2] There is emerging evidence that the factors related to the LBP disorder are different for each individual, and that there is no uni-factorial treatment program that is effective for all patients with LBP. It has been suggested that sub-grouping the patients and targeting interventions to their individual needs is important in providing optimal care for patients with LBP.[3-5]

Several brief first-stage screening questionnaires have been developed to facilitate the sub-grouping of patients with LBP according to their psychological features.[6-10] Two of these well-known measures are the StarT Back, which identifies patients with low, medium or high psychological risk factors,[7] and the Distress and Risk Assessment Method, which categorizes the patients into 'normal', 'at risk', 'distressed-depressive' and 'distressed-somatic' groups.[8] Considerable attention has been paid to the reliability and validity of screening questionnaires,[7,8,11,12] but relatively little attention has been paid to the screening validity of signs and symptoms identified during a clinical examination, or to assessments made by clinicians. Recently, Jellema et al.[13] concluded that the risk estimates made by general practitioners were just as reliable as validated instruments in assessing patients with LBP. The focus of the present study was the first-stage screening validity of signs and symptoms.

A number of signs and symptoms are thought to be psychological screeners for patients with LBP manifested as limited lower back mobility,[14] a non-centralization pain pattern,[15] and an inconclusive mechanical diagnosis.[16] Waddell[1] advises clinicians to use illness behavior measurement instruments, such as the pain drawing, Waddell signs, and Waddell symptoms. High scores for these illness behavior instruments should warn the clinician to manage the psychosocial and behavioral aspects of the patient's illness carefully.[1] Although it has been demonstrated that various signs and symptoms are associated with limitations in psychological functioning in patients with LBP,[1,14-17] there is no empirical evidence that they are valid for the clinical assessment of individual patients.[17,18]

Therefore, the purpose of this study was to determine the first-stage screening validity of a wide variety of signs and symptoms identified during a clinical examination to identify those patients with chronic low back pain (CLBP) who need additional psychological assessment in an outpatient rehabilitation setting. Our final aim was to develop a clinical prediction rule for calculating the need for psychological assessment in individual patients with CLBP in secondary care.

Materials and methods

Recruitment of patients

All patients with CLBP who attended the outpatient rehabilitation department of the Medical Centre Alkmaar (MCA) in the Netherlands between September 2000 and June 2005 were candidates for inclusion in this study. Eligible for participation were patients who were 18 years of age and older, with LBP for more than three months, with or without leg symptoms as their primary problem. Patients were excluded if they had inadequate command of the Dutch language, had received previous treatment for CLBP in a multidisciplinary rehabilitation setting, or were unwilling to participate. Patients who were known to have, or were suspected of having specific causes of CLBP (e.g. malignancy, fractures, spinal stenosis, severe cases of spondylolisthesis) were excluded, but patients with osteoarthritis and degenerated or protruded discs were eligible for participation in the study. The Regional Medical Ethics Committee approved the study protocol (registration number: MEC 00-29), and before participating in the study all patients gave written consent.

Design

All the data were collected during a screening period of three weeks, in which each patient underwent comprehensive assessment by a rehabilitation team consisting of a physical therapist, an occupational therapist, a social worker, and a psychologist. The main purpose of this screening period was to identify patients who were likely to benefit from an intensive multidimensional rehabilitation program, and to match treatment modalities to individual patient needs. A psychologist assessed the existence or absence of relevant psychological disturbances in all participants, which was considered as the reference standard. A physical therapist collected the outcomes of a wide variety of signs and symptoms, to be compared with the outcome of the reference standard. During the observation period the psychologist and the physical therapist were unaware of each other's findings until these were discussed in a multidisciplinary team meeting to formulate a treatment strategy. The first author (AA) monitored adherence to the study protocol, and collected the reports from the psychologist and physical therapist before the multidisciplinary team meetings and before any treatment started.

Reference standard

Nine psychologists participated in the study, three of whom were licensed clinical psychologists and six were following a two-year post-Masters education course to become clinical psychologists. The assessments consisted of two diagnostic interviews with each patient (1½ hours in total) and a battery of psychological tests; the Dutch Pain Cognition List (PCL),[19] the Dutch version of the Coping Strategy Questionnaire (CSQ),[20,21] the Beck Depression Inventory (BDI),[22,23] the Symptom Checklist-90-Revised (SCL-90-R, modified Dutch version),[24,25] and the Tampa Scale for Kinesiophobia (TSK).[26,27] The Minnesota Multiphasic Personality Inventory-2 (MMPI-2)[28] was administered if the psychologist needed additional information. The interviews were used to communicate the test procedure and the test results, and to explain or review specific items.

The psychologists were asked to dichotomize their clinical findings into relevant psychological disturbances, yes or no. We regarded relevant psychological disturbances as important psychological obstacles to recovery (e.g. severe depression, fear and anxiety, and feelings of anger and hostility). If there was any doubt, the patient was classified into an intermediate or mixed group. The psychologist's decision-making process reflected clinical practice, and was not standardized.

Potential psychological screening measures

The clinical assessments made by the three participating physical therapists took place during three one-hour sessions. The first assessment started with Waddell's non-organic sign-testing and three lumbar mobility measurements. This was followed by the intake of questionnaires, history-taking and a comprehensive physical examination, to establish the existence of a directional preference and to identify any recognizable mechanical pattern. The questionnaires, completed by the patients before the first session, included questions about the following: age, gender, lower back surgery, duration of CLBP, Waddell symptoms, level of pain, use of pain medication for CLBP, participation in sport activities during the past four weeks, and the distribution of pain on a pain drawing. The purpose of the second and third assessments was to re-assess directional preference and mechanical pattern.

The participating physical therapists had more than 10 years of experience in the clinical assessment and treatment of LBP patients in a rehabilitation setting. They had attended four postgraduate courses (A-D) in Mechanical Diagnosis and Therapy (MDT or McKenzie method), and one physical therapist was MDT-certified. Two of the three physical therapists had followed a post-graduate course in manipulation and

mobilization techniques, and were certified manual therapists.
The signs and symptoms assessed during the physical therapy sessions are described in detail below.
Pain. Pain was measured on a visual analogue scale (VAS) of 100 mm, ranging from 0 (no pain) to 100 (unbearable pain). The VAS has been found to be user-friendly, valid and reliable.[29-31]
Pain medication. Participants were asked about their use of analgesic medication for their current LBP symptoms, but they were not asked about the exact types of pain medication. The score was dichotomized to pain medication every day versus no pain medication, or not every day.
Sport activities. This was assessed with a single question: 'How many times did you participate in sport activities during the past four weeks?' The frequency was dichotomized into zero versus one or more times in the past four weeks.
Pain drawing. The pain drawing was recorded according to Margolis et al.[32] who divided the body shown in a diagram into 45 anatomical areas. The body areas are assigned weights according to the percentage of body surface that they cover. The possible scores vary from 0 (no pain) to 100 (total body pain). The inter-rater reliability of this method has been found to be good in 51 patients with CLBP.[33]
Waddell signs. Waddell et al.[34] developed a checklist of 8 behavioral or non-organic signs, divided into five categories, which became known as the 'Waddell score'. The categories include tenderness (superficial and non-anatomical tenderness), simulation (axial loading and rotation), distraction, regional disturbances (weakness and sensory) and over-reaction. Waddell et al.[34] considered a score to be positive if three or more categories were scored positive. In the present study the scores for the 8 individual signs were summed up, resulting in a minimum score of 0 (no signs of illness behavior) and a maximum score of 8 (maximum signs of illness behavior) according to the recommendations made by Apeldoorn et al.[35] The inter-rater and intra-rater reliability of Waddell's non-organic sign-testing has been found to be moderate to good, respectively.[34,35]
Waddell symptoms. Waddell et al.[36] developed a checklist of 7 behavioral or non-organic symptoms, focusing on symptoms that are vague, and not normally assessed in general clinical practice, such as pain in the tip of the tailbone, and pain in the entire leg. Every symptom that is present scores one point, and all the points are summed up to calculate the total score, with a minimum score of 0 (no symptoms of illness behavior) and a maximum score of 7 (maximum symptoms of illness behavior). The test-retest reliability of this checklist has been found to be sufficient in 30 patients with

LBP.[36] For the purpose of the present study the symptoms were translated into Dutch.
Mobility. The active flexion and extension range of motion (ROM) of the lumbar spine was measured with the re-modified Schober skin distraction method, developed by Van Adrichem et al.,[37] and the fingertip-to-floor test.[38] For the first two measurements the examiner places two marks on the lumbar-sacral spine - the first mark in the middle of the line joining the dimples of Venus, and the second mark 15 cm. above the first mark. The lumbar flexion ROM values range between 15 cm. (no flexion mobility) and > 15 cm., and the extension ROM values range between 15 cm. (no extension mobility) and < 15 cm. For the third measurement, the finger-to-floor test, mobility values vary between (a minimum of) 0 cm., indicating normal (or hyper-) mobility, and values of ± 50 cm. and above, indicating hypomobility. The measurements have been found to be reliable and valid in clinical practice.[37,38]
Two physical therapists (AA and HB) examined the inter-rater reliability of the three mobility tests for a subset of 142 patients, with a test-retest interval of 15 minutes. During the study, the examiners were blinded for each other's findings. Intraclass correlation coefficients (ICCs), using a two-way mixed effect model (absolute agreement definition),[39] were calculated for the continuous normally distributed data of the flexion and extension ROM. A Spearman's ρ correlation coefficient was calculated for the fingertip-to-floor test, because these data were not distributed normally (a considerable number of patients scored the minimum distance of 0 cm.). The inter-rater reliability was sufficient for the flexion ROM (ICC = 0.86 [95% confidence interval (CI) 0.74 to 0.91]), the extension ROM (ICC = 0.66 [95% CI 0.51 to 0.76]) and the fingertip-to-floor test (Spearman's r = 0.96).
Mechanical diagnosis. To establish the mechanical diagnosis, the physical therapist started with a standardized assessment according to the MDT method.[40] The reliability and validity of this classification system (posture, dysfunction and derangement) has been demonstrated in a number of studies.[41] Subsequently, lower back and pelvic instability was determined, based on history-taking (e.g. previous or current pregnancy, physical traumata, increasing episodes of pain, painful catches) and tests (e.g. aberrant movements during flexion and extension, difficulties performing the active straight leg raise test).[42] The CLBP of the patient was labelled 'inconclusive' if the mechanical presentation did not fit into one of the MDT classifications, and no instability syndrome could be identified.
Directional preference. A directional preference was established if certain postures or repeated end-range movements in one direction (e.g. flexion) were associated with symptoms to improve or centralize (pain moving from a distal to a more proximal

area), and in the opposite direction (e.g. extension) causing the symptoms to worsen or peripheralize (pain moving from a proximal to a more distal area). The improved or centralized symptoms had to be retained in a neutral standing position, for at least 1 minute. A directional preference was not established if the symptoms and the pain immediately reappeared. The establishment of a directional preference is an essential element in the MDT method. The patients were categorized as having a directional preference, yes or no. The test-retest reliability of establishing a directional preference in patients with LBP has been found to be sufficient.[43]

Analysis

First, the outcome of the reference standard was dichotomized by omitting the patients who were classified in the intermediate group, because this group was too small for any meaningful analyses. Secondly, differences between the group with and without relevant psychological disturbances were analysed for all signs and symptoms that were assessed, using appropriate statistical methods. Thirdly, to obtain insight into the individual assessments made by the psychologists, univariate testing was applied with the psychologist's assessment as the dependent variable and the total scores of the BDI, the TSK and the SCL-90-R, and the individual items of the CSQ and the PCL as the independent variables. Fourthly, a backward stepwise multivariable logistic regression (likelihood ratio) modeling procedure was applied to evaluate the relative contributions of the different variables to relevant psychological disturbances, entering variables with p-values $\leq .05$ on bivariate testing. The p-value for deleting variables was set at 0.10. All variables were entered simultaneously into the multivariable model. Fifthly, for the variables retained in the regression model, a receiver operator characteristic (ROC) curve was constructed by graphing the true-positive rate (sensitivity) against the false-positive rate (1-specificity) for each cut-off point, and then calculating the area under the curve (AUC). An AUC statistic reflects the accuracy of a measure for discriminating between two outcomes, and the area can range between 0.50 and 1.0. The strength of the discrimination was classified as following: $0.7 - < 0.8$ acceptable, $0.8 - < 0.9$ excellent, and ≥ 0.9 outstanding.[44] We also calculated Nagelkerke's R^2, which is an indicator of explained variance. The explained variance of predictive models presented in the literature generally varies between 0.25 and 0.50. Sixthly, for the final multivariable model, we developed a prediction rule to provide an estimate for individual patients with relevant psychological disturbances, according to the psychologists. The probability (p) of relevant psychological disturbances was predicted by $p = 1/(1+\exp - [a + bx \ldots])$. Finally, for clinical use, we developed a score chart by linear

transformation of the regression coefficients. We divided the regression coefficients by the lowest coefficient, and rounded them off to the nearest integer to form the scores for the variables. The sum of the scores corresponds with the probability of having relevant psychological disturbances, according to our reference standard. All analyses were carried out in SPSS version 15.0 and VassarStats.[45]

Results

A total of 229 patients fulfilled the inclusion criteria; 63% females and 37% males. Their median age was 43.9 years (standard deviation 11.0), and the mean duration of their CLBP was 84 months (inter-quartile range 24-180). Table 1 shows the frequency distributions and descriptive statistics for the main characteristics of the participating patients.

Table 1 Main characteristics of the participants (n=229)

Female (%)	63.3
Age in years	43.9 (11.0)
Dutch nationality (%)	96.1
Duration of CLBP in months †	84 (24-180)
Current CLBP (0-100)	53.2 (23.2)
Low back operations (%)	19.6
Marital status	
Married/living with a partner (%)	87
Single/divorced (%)	13
Employed (%)	84.4
Employed and currently working (%)	57.4
Currently doing modified work (%)	27.4
Currently working less hours (%)	50.5
Employed and currently on sick leave due to CLBP (%)	42.6
No job / retired (%)	15.6
SCL-90-R (90-450)	144.0 (39.6)
TSK (17-68)	38.4 (7.1)
BDI (0-63)	10.6 (7.2)

Values are the mean (standard deviation) unless otherwise indicated.
CLBP, chronic low back pain; SCL-90-R, Symptom Checklist-90-Revised (modified Dutch version); TSK, Tampa Scale of Kinesiophobia; BDI, Beck Depression Index
† Median and inter-quartile range

Psychologists' assessments

According to the psychologists' assessments, 102 patients had relevant psychological disturbances, 92 had no relevant psychological disturbances, and 22 were categorized into the intermediate group. Nine patients did not complete the entire psychological assessment, and for 4 patients the psychologist's assessment was not recorded. The group of patients who had a psychological assessment (n = 216) did not differ significantly ($p > 0.05$) from the group of patients who had no (reliable) psychological assessment (n = 13) with regard to the baseline variables shown in Table 1. The patients with no psychological assessment and the patients categorized as intermediate were omitted before further analysis, resulting in a study sample of 194 patients.

The psychologist's assessment relevant psychological disturbances was significantly associated ($p < .01$) with generalized psychiatric distress, kinesiophobia, depression, pain impact, catastrophizing, acquiescence and praying or hoping (Table 2).

Univariable and multivariable results

Univariable analysis revealed that the following 10 of the 17 measured signs and symptoms were significantly associated with the presence of relevant psychological disturbances: daily use of pain medication for CLBP, an inconclusive mechanical diagnosis, absence of a directional preference, increased fingertip-to-floor distance, Waddell signs, high scores for the pain drawing, reduced low back extension, and higher levels of current CLBP, CLBP during the past week, and pain in the leg during the past week (Table 3).

Multivariable logistic regression resulted in a model with the following variables: presence of Waddell signs, high scores for the pain drawing, absence of a directional preference, and daily use of pain medication for CLBP (see Table 4). The AUC was 0.81 (95% CI 0.75 to 0.87) and the explained variance was 37% (Nagelkerke's R2 = 0.37).

Table 2 **Comparison of several psychological tests in the psychologically disturbed and non-disturbed patients with CLBP**

Variables	Psychological assessment (reference standard)		p-value
	Not disturbed (n=92, 47%) mean (SD)	Disturbed (n=102, 53%) mean (SD)	
SCL-90-R (generalized psychiatric distress, 90-450)	124.2 (18.7)	161.3 (47.3)	<0.001*
TSK (kinesiophobia,17-68)	35.1 (5.9)	40.6 (6.9)	<0.001*
BDI (depression, 0-63)	6.8 (4.4)	13.7 (7.3)	<0.001*
PCL			
Pain impact (17-102)	39.8 (9.9)	48.5 (11.0)	<0.001*
Catastrophizing (17-102)	38.2 (9.9)	48.4 (11.6)	<0.001*
Outcome efficacy (7-42)	21.8 (3.9)	21.8 (5.0)	0.950
Acquiescence (4-24)	8.8 (2.6)	10.7 (3.3)	<0.001*
Reliance on health care (5-30)	19.6 (2.8)	19.3 (3.0)	0.543
CSQ			
Diverting attention (0-60)	17.0 (12.3)	19.7 (12.9)	0.153
Reinterpreting pain sensations (0-60)	11.1 (9.9)	13.6 (10.8)	0.106
Coping self-statements (0-60)	35.1 (13.3)	34.3 (13.0)	0.690
Ignoring pain sensations (0-60)	27.4 (13.1)	25.0 (13.3)	0.226
Increasing activity level (0-60)	25.5 (11.5)	25.3 (11.0)	0.877
Praying or hoping (0-60)	16.4 (11.1)	21.2 (13.6)	0.009*
Catastrophizing (0-60)	14.1 (10.1)	24.5 (12.5)	<0.001*
Control over pain and ability to decrease pain (0-20)	10.0 (5.0)	8.6 (5.0)	0.063

All variables were compared with the independent sample t-test, * significant at $p<0.05$
CLBP, chronic low back pain; SD, standard deviation; SCL-90-R, Symptom Checklist-90-Revised (modified Dutch version); TSK, Tampa Scale of Kinesiophobia; BDI, Beck Depression Index; PCL, Pain Cognition List; CSQ, Coping Strategy Questionnaire

Table 3 **Comparison of several signs and symptoms in the psychologically disturbed and non-disturbed participants**

Variables	Psychological assessment (reference standard)		p-value
	Not disturbed (n=92, 47%) mean (SD)	Disturbed (n=102, 53%) mean (SD)	
Age in years	44.0 (10.9)	42.9 (11.1)	0.520
Gender (% female)	63.0	64.7	0.810
Duration of CLBP in months†	78 (24-180)	108 (36-216)	0.138
Low back surgery (%)	22.2	16.2	0.289
Daily use of pain medication for CLBP (%)	34.9	58.6	0.001*
No sport activities in past four weeks (%)	64.4	63.0	0.836
Inconclusive mechanical diagnosis (%)	7.6	33.7	<0.001*
No directional preference (%)	61.4	81.3	0.003*
Pain drawing (0-100)	15.1 (8.4)	23.2 (14.1)	<0.001*
Waddell signs (0-8)†	0 (0-1)	2 (1-4)	<0.001*
Waddell symptoms (0-7)	2.3 (1.5)	2.7 (1.4)	0.060
Current CLBP/leg pain (0-100)	47.5 (21.5)	57.3 (22.1)	0.002*
CLBP in past week (0-10)	5.4 (2.1)	6.4 (1.9)	<0.001*
Leg pain in past week (0-10)†	3 (0-5)	5 (2-7)	0.001*
Fingertip-to-floor distance while bending forward with straight knees (0-90 cm)†	13 (0-25)	24 (5-33)	0.005*
Lumbar extension ROM (modified Schober)‡	13.8 (0.6)	14.1 (0.6)	0.002*
Lumbar flexion ROM (modified Schober)╣	20.4 (1.1)	20.2 (1.5)	0.380

Values are the mean (standard deviation) unless otherwise indicated.
Continuous variables were compared with the independent sample t-test, categorical and skewed continuous distributed data with the Mann-Whitney U-test, and ordinal variables with the X^2 test
CLBP, chronic low back pain; ROM, range of motion;
* significant at p<0.05; † Median plus inter-quartile range; ‡ Range: 15 cm (no mobility) to 10 cm (hypermobility); ╣ Range: 15 cm (no mobility) to 25 cm (hypermobility)

Table 4 **Results of multivariable logistic regression with the group with relevant psychological disturbances as outcome versus the group with no relevant psychological disturbances**

Variable	OR (95% CI)	p-value
Waddell signs (0-8)	1.49 (1.16, 1.90)	0.002
Pain drawing (0-100)	1.07 (1.03, 1.11)	0.002
No directional preference	2.59 (1.12, 5.99)	0.026
Daily use of pain medication for CLBP	2.16 (1.01, 4.63)	0.048

OR, odds ratio; CI, confidence interval; CLBP, chronic low back pain;

Score chart

Figure 1 shows the score chart for calculating the chance of patients with CLBP having relevant psychological disturbances, according to the psychologists. For instance, a patient with 5 Waddell signs, a pain drawing score of 20, no directional preference, and using pain medication for CLBP daily has a score of 30 (5*6)+20+14+12 = 76, which implies a 90-100% chance of having relevant psychological disturbances.

Figure 1 **Score chart for the chance of patients with CLBP having relevant psychological disturbances versus no relevant psychological disturbances**

Instruction: **For every variable, the given weights need to be filled in to form a total score. In addition, the probability of relevant psychological disturbances assessed by psychologists can be determined, using the table next to the score chart.**

Variables		Total score	Probability
Number of Waddell signs (0-8)	….. x 6	<21	<20%
Pain drawing score (0-100)	score	21-29	20-30%
No directional preference	14	30-35	30-40%
Daily use of pain medication for CLBP	12	36-41	40-50%
	+	42-48	50-60%
Total score	…	49-54	60-70%
		55-62	70-80%
		63-74	80-90%
		>74	90-100%

The probability of relevant psychological disturbances was determined by p=1/[1+exp - (-2.786 + 0.395 x number of Waddell signs (0-8) + 0.952 x no directional preference + 0.770 x daily use of pain medication for CLBP + 0.066 x pain drawing score (0-100)].
CLBP, chronic low back pain

Discussion

In this study, the psychologists classified approximately half of the patients with CLBP (53%) as having relevant psychological disturbances, which is similar to previously reported results.[46,47] None of the demographic variables (age or gender), but 10 of the 15 clinical characteristics that were assessed, were significantly associated with the presence of relevant psychological disturbances. After applying multivariable analysis techniques, we developed a screening instrument consisting of four variables that can be used to identify patients with CLBP who will benefit from additional psychological assessment in secondary care. The final model suggested a reasonable explained variance (Nagelkerke's $R^2 = 0.37$) and good overall discriminative power (AUC = 0.81). The inclusion of Waddell signs and the pain drawing as part of this screening instrument contradicts the conclusions of recent reviews.[17,18] Fishbain et al.[18] concluded, in a review focusing on the Waddell signs, that they do not correlate with psychological distress, do not discriminate organic from non-organic problems, and represent an organic phenomenon. Carnes et al,[17] evaluating the validity of the pain drawing as a psychological assessment tool, concluded that there is no high quality evidence that pain drawings can be used as crude indicators of a disturbed psychological state. It must be noted that the authors of these reviews based their conclusions on the individual screening value of the measurements. In the present study the individual screening value of the Waddell signs and the pain drawing was also not very high, but our results showed that if these measurements are used as part of a wider set of screening measurements they can become clinically useful. Other reasons for the contradictory findings might be due to differences in the target population and differences in the reference standards. Our analysis was limited to patients with long-lasting CLBP and the assessments made by the psychologists were the reference standard. Finally, we mention two studies in which the psychological screening validity of the Waddell signs and the pain drawing was compared with the screening validity of psychological questionnaires. Main et al.[8] concluded that the Waddell signs had less discriminative power than the Modified Somatic Perception Questionnaire and the modified Zung Depression Index to measure psychological distress in patients with LBP in orthopaedic departments and pain clinics. Greenough et al.[48] reported similar results, and concluded that both the Waddell signs and the pain drawing failed to identify psychological disturbances as accurately as the outcome of a set of psychological tests. Greenough et al.[48] recruited patients with LBP in orthopaedic departments with a wide variation in the duration of their LBP and their disability, some

of whom did not currently have LBP. The results of these two studies suggest that there could be psychological screening questionnaires that are more accurate than the Waddell signs and the pain drawing, but it is inappropriate to draw firm conclusions as yet, because the reference standards, the research settings and the patient samples differed across the studies.

The third and fourth measurements of our screening instrument focused on directional preference and the daily use of pain medication for CLBP, and these findings are in line with previously reported results.[15,49-53] Pain medication might be useful for flares of CLBP, and for a sub-group of carefully selected patients with CLBP who have failed to benefit from all other types of treatment.[54] However, continuous use of medication by patients with CLBP remains controversial, because these patients can become dependent on medication. Previous results suggest that pain medication for many patients with CLBP is of limited use, and must be considered as dysfunctional pain behavior.[55] The fourth variable in our final model, i.e. the absence of a directional preference, is probably the most unfamiliar as a potential screening measure of psychological disturbances. A positive association between the absence of a directional preference and Waddell signs has been reported earlier.[56,57] As early as 1999, Werneke et al.[53] suggested that in patients whit no directional preference additional psychological screening might be useful. Unfortunately, definitions of the establishment of a directional preference, including the centralization phenomenon, vary considerably in the literature, and different time-frames (from one to seven visits) have been used to measure directional preference.[53,58] Although our findings are in line with previous reports, more research has to be carried out to formulate the optimal operational definition of directional preference.

Notably, the Waddell symptoms were found to be of borderline significance. Compared to the Waddell signs, the Waddell symptoms have been studied less extensively. In the present study the internal consistency of the Waddell symptoms was low (Cronbach's alpha 0.42), which therefore makes it questionable whether all the items are a manifestation of the same underlying construct. When four symptoms were omitted, a checklist consisting of three questions ('does your *whole* leg ever become painful?', 'does your *whole* leg ever go numb?' and 'does your *whole* leg ever give way?') reached a much higher internal consistency (0.60), and this warrants further research on the construct validity of the checklist.

For clinical use, a score chart was developed for calculating the probability of patients with CLBP having relevant psychological disturbances (Figure 1). Although it was not our primary aim to calculate a relevant cut-off score, it is useful to consider the

interpretation of various scores based on our data. The general rule for choosing cut-off values for screening instruments is to minimize false negative results and to accept a moderate number of false positive results.[59] However, the optimal cut-off point is dependent on the consequences of false positive and false negative results. For the present study, the relative 'costs' associated with both types of misclassification are unknown. Therefore, the best choice is probably to minimize the false negative and false positive test results, and this would correspond to a cut-off value of 42 points.

Three of the variables on the score chart (Waddell signs, daily use of medication for CLBP, and the pain drawing) are very easy and quick to assess, but for the fourth variable (directional preference) a detailed examination and a trained observer are needed. Despite the time-consuming character of the assessment of directional preference, we consider it important, because our findings are in line with previous reports in the literature, and suggest that it can assist in tailoring the assessments to the needs of the patient.

Strengths and limitations

Some strengths and limitations of this study must be mentioned. One of the challenges was the choice of a reference standard, because no universally accepted reference standard is available. The common method is the use of valid psychological questionnaires as reference standard. However, we chose the assessments made by the psychologists as reference standard, because this corresponded best with the aim of our pragmatic study. Moreover, it has been suggested that a comprehensive psychological assessment made by a psychologist could provide more valid results.[60] Psychologists can use information from interviews and questionnaires about the patient's personality, combined with emotional, cognitive, behavioral, environmental, and historical factors, to understand the patient's clinical signs and symptoms.[61] The benefits of a comprehensive psychological assessment, compared to validated psychological questionnaires, have already been supported by research findings.[62]
Nevertheless, we realize that the use of the psychologist's assessment as reference standard may also have introduced bias. The psychologist's decision-making process was not standardized, and there is uncertainty about which constructs the reference standard contained. However, the psychologists used the outcomes of validated psychological questionnaires, and their assessments of relevant psychological disturbances were significantly associated with generally accepted important psychological factors such as generalized psychiatric distress, kinesiophobia,

depression, and catastrophizing.

We asked the psychologists to dichotomize their findings into relevant psychological disturbances or no relevant psychological disturbances. This was done for the purpose of analysis, and was a (major) simplification of the holistic approach of our psychologists. In this holistic approach, patients with CLBP have a complex and interactive psycho-physiologic behavior pattern, and the patient's position is actively moving in a dynamic process along a continuum between a distinct organic pathology and extreme psychosocial or behavioral dysfunctioning.

Another limitation is that most of the psychological assessments were made by psychologists who were training to become clinical psychologists, which may limit the validity of the reference standard. However, they were all informed about the outcome of a comprehensive set of psychological questionnaires, and were coached by experienced clinical psychologists.

The signs and symptoms that we selected were used in daily practice by the physical therapists participating in our study. They are documented in the literature and, in general, they are easy to administer and interpret. However, it cannot be ruled out that valuable variables (e.g. disability measurement instruments, such as the Roland Disability Questionnaire)[63] have been missed. Therefore, the results of this study should be interpreted according to the signs and symptoms that were chosen.

Another point of concern is the risk of diagnostic suspicion bias (i.e. the finding for one characteristic may be modified by previous findings) in the assessment of the signs and symptoms. We tried to minimize this bias by testing the Waddell signs and the mobility measurements at the beginning of the examination procedure, i.e. before questionnaire intake, history-taking, and the rest of the physical examination. To minimize the risk of diagnostic suspicion bias in the MDT classification procedure and the assessment of directional preference, we used the results of three visits instead of one single visit. However, if such a bias was present, we believe that it would have caused an over-estimation of the associations that were found.

A last point of concern is potential selection bias. Our data were collected from only one outpatient rehabilitation center. The patients were predominantly from a Caucasian, middle-aged working population with CLBP. The mean scores for the pain measurements and validated psychological questionnaires reflected moderate pain and moderate psychological dysfunctioning. Notably, the characteristics of the participants in the present study are fairly consistent with those reported in other studies of patients with CLBP treated in outpatient rehabilitation centres.[64-66] Although potential selection bias cannot be excluded, we consider the risk to be very low.

General conclusions

It has been reported that psychopathology that is unrecognized and untreated can significantly interfere with the successful rehabilitation of patients with CLBP.[67] However, not all patients with CLBP demonstrate relevant psychological risk factors, and it seems reasonable to assume that only a sub-group of these patients should need careful psychological assessment. Therefore, to guide the assessment process, clinicians need empirically validated first-stage screening instruments to measure psychological disturbances in patients with CLBP. To our knowledge, this is the first study in which a comprehensive psychological assessment has been used as a reference standard in order to establish a clinically useful screening instrument for the identification of patients with CLBP who might benefit from additional psychological assessment in an outpatient rehabilitation setting. Further research is needed to confirm our preliminary results, and to develop and evaluate screening procedures with diagnostic and therapeutic credibility in various different settings.

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