

# Prognostic Factors for Improvement in Pain and Disability after Multidisciplinary Rehabilitation in Patients with Chronic Neck Pain

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## Research article

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# Abstract

**Background:** Recent clinical studies support the effectiveness of chronic neck pain specific multidisciplinary biopsychosocial rehabilitation programmes, but prognostic factors for improvement in pain and disability are unknown. The aim of this study was to identify predictors of improvement in patients with chronic neck pain after participation in a three-week multidisciplinary biopsychosocial rehabilitation programme.

**Methods:** In this observational prospective cohort study patients were assessed at the beginning and the end of a multidisciplinary biopsychosocial rehabilitation programme. Inclusion for participation in the rehabilitation programme depended upon an interdisciplinary pain assessment. Consecutive patients who fulfilled the inclusion criteria were invited to participate in the study. A total of 112 patients participated. The primary outcomes, pain and disability, were measured by the Northern American Spine Society questionnaire (NASS), quantified by effect sizes (ES), and modelled with various co-factors. Secondary outcomes were mental health measured by the Short-Form 36 and total cervical active range of motion measured by a reliable, validated cervical range of motion instrument.

**Results:** Patients' mean age was 59.7 years (standard deviation=10.8); 70.5% were female. Patients improved significantly ( $p<0.001$ ) in pain+disability (ES=0.56), mental health (ES=0.45) and cervical range of motion (ES=0.39). Prognostic factors for improvement in pain+disability were worse baseline scores (partial, adjusted correlation  $r=0.41$ ,  $p<0.001$ ), higher age ( $r=0.22$ ,  $p=0.024$ ), higher improvement in cervical range of motion ( $r=0.21$ ,  $p=0.033$ ) and higher improvement in mental health scale ( $r=0.20$ ;  $p=0.047$ ).

**Conclusions:** Better outcomes for patients with improvement in neck range of motion, improvement of mental health, and higher age support the use of multidisciplinary biopsychosocial rehabilitation that combines physical and psychological treatment components. Furthermore, the results suggest that older patients may improve more compared to younger patients.

## Background

Neck pain is a musculoskeletal health condition with a high burden of disease; epidemiological studies report lifetime prevalences from 14–71% (1). In the Global Burden of Disease Study 2017, neck pain ranked 9th in terms of “years lived with disability” (YLD) in females and 11th in males (2). Western Europe has the highest prevalence of neck pain with an age-standardised rate of 4,631 cases per 100,000, followed by East Asia with 4,590 cases. The lowest prevalence rates are in tropical Latin America (2,506 per 100,000) and Andean Latin America (2,512 per 100,000) (3). The point prevalence increases with age until 45–49 years in females and 50–54 years in males, then it declines slowly while remaining high (3). A significant proportion of patients (37–47%) continues to suffer from neck pain one year after the onset of complaints (4, 5).

Clinical guidelines and reviews recommend several treatment options for chronic neck pain (CNP), but due to the small number of neck-pain-specific clinical trials, the evidence for neck-pain-specific interventions is only weak to moderate (6–9). The strongest existing evidence suggests benefits from local strengthening exercises and from multimodal exercises in the neck and shoulder region. Other treatment options with less evidence include mobilization of the cervical or thoracic spine, aerobic exercises, patient education, and psychological interventions (6–11). Recent clinical studies demonstrated that CNP-specific multidisciplinary biopsychosocial rehabilitation programmes (MBR) could improve pain and physical function for at least one year in patients who did not respond to less complex interventions (12, 13).

Risk factors for neck pain include sociodemographic factors such as female gender (4, 5), physical health factors including low endurance of neck extensor muscles (14), and psychological factors such as depression (14). Predictors for better pain relief after rehabilitation of CNP patients who had a previous whiplash injury are more pain at baseline, improvement in catastrophising coping strategies, and lower catastrophising at baseline, according to a cohort study with six months of follow-up (15). However, it remains unclear if the results are generalizable to CNP patients without previous whiplash injury. Knowledge of associations between predictors would allow adapting the contents of MBR to patients who currently show less improvement; identifying associations between changes during treatment and outcome, moreover, could confirm or disprove the actual content of MBR. Therefore, the objective of this study was to identify prognostic factors of improvements in pain and disability of CNP patients after participation in an intensive three-week outpatient MBR.

## Methods

### Study Design

An observational prospective cohort study, with assessments at the beginning of treatment and at discharge, was conducted at the day clinic in the Department of Physical Medicine and Rehabilitation at University Hospital, LMU Munich, Germany. The study was carried out in compliance with the Helsinki Declaration 2004. All participants provided signed informed consent prior to study participation. At the time of data collection, ethical approval was not mandatory for observational studies not affecting treatment and not requiring additional clinical tests (i.e. naturalistic design).

### Participants

Patients were referred by their family physician or a specialist to an interdisciplinary assessment that was conducted by a specialist in Physical and Rehabilitation Medicine (PRM), a physiotherapist, and an occupational therapist. In addition, a psychologist on the treatment team assessed patients who were suspected of a mental health disorder.

At the end of the assessment, the treatment team either recommended participation in a three-week MBR programme or other treatment options. The treatment team recommended MBR according to predefined inclusion criteria, appraisal of results of standardised clinical tests and standardised patient questionnaires, and the global impression of the day clinic treatment team. The predefined inclusion criteria were CNP (pain lasting at least three months, with or without pain irradiation in the upper limbs), previous outpatient physical therapy that was not providing relevant improvements according to oral questioning of the patient, limitations of activities and participation, and sufficient skills of the German language to follow the instructions of the MBR. MBR was not recommended if patients had severe somatic or mental illness limiting the ability to participate in the MBR (e.g. major depression), acute neck trauma in the past three months, former whiplash injury with proven structural damage, new neurological deficits in the last three months, chronic neurological deficits that prevent participation in exercise interventions, unclear dizziness or vertigo, diffuse idiopathic skeletal hyperostosis (DISH), reduced mobility of shoulder abduction or flexion less than 90°, or an ongoing pension process.

After meeting with the treatment team, the physician explained the recommendation to each patient. In conversation, patients expressed their expectations and goals for treatment and their treatment preferences. Within the framework of participatory decision-making, the recommendation could change. More details about the assessment have been described elsewhere (12).

All consecutive patients who participated in the MBR, provided informed consent, and had analysable North American Spine Society questionnaire (NASS) pain + disability scales (16, 17) at baseline and discharge were included in the study.

## Data Collection

At the beginning and the end of the MBR programme, patients completed a set of standardised patient questionnaires and were evaluated by standardised clinical tests according to a written protocol. The analyses in this study used the results of the NASS questionnaire (16, 17), the mental health scale from the Short Form 36 (SF-36) questionnaire, (18) the standardised comorbidity questionnaire (19), sociodemographic questions, and the results of a measure of cervical spine range of motion (ROM) with the cervical range of motion instrument (CROM) (20).

## Study Intervention

Patients completed a three-week MBR programme, with a total of nine treatment days and 44 treatment hours. The treatment team consisted of a specialist in PRM, physiotherapists, occupational therapists, psychologists, medical massage therapists, and a swimming trainer. Most treatments were provided in groups, but all participants had two individual physiotherapy lessons occurring at the beginning and the end of the programme. In the initial individual physiotherapy lesson, patients were trained in deep neck muscle strengthening exercises using biofeedback (21). In the final individual lesson, patients were

instructed in individual home exercises. Treatments were provided in groups, with up to five participants in practical lessons and up to 10 participants in educational lessons and pool therapy. The MBR included land-based group exercises, gym training, pool exercises, occupational training, psychological lessons (including learning relaxation strategies), instructions for self-help techniques, patient education by a PRM specialist, and interactive group discussions at the end of each week with the complete treatment team. The physician provided daily ward rounds in the group and individual appointments on demand. Details of the intervention have been described elsewhere (12).

## Measures

### *North American Spine Society questionnaire (NASS) (16, 17)*

The NASS is a condition-specific instrument with specific modules for neck pain and low back pain that measure pain, disability, and neurogenic symptoms. In the primary validated version of the neck-pain-specific version, 10 items constitute the pain + disability scale and eight items make up the neurogenic symptom scale. A subsequent validation study revealed a three-factor structure in which the pain + disability scale is separated into a pain scale (two items) and a disability scale (eight items) (22, 23). The scales range from 1 (best health) to 6 (worst health).

### *Short Form 36 (SF-36) Mental Health (18)*

The mental health scale is one of eight scales from the generic health status measure SF-36. It consists of five items and ranges from 0 (worst health) to 100 (best health). A recent review showed associations between changes of the SF-36 mental health scale and the course of pain in different chronic pain conditions (24).

### *Cervical Range of Motion instrument (CROM) (20)*

The CROM (Performance Attainment Associates, 3600 Labore Road, Suite 6, St. Paul, MN 55110 – 4144) measures cervical spine ROM in degrees in six directions of movement: flexion, extension, lateral flexion, rotation, as well as suboccipital flexion and extension. The total active cervical ROM was calculated as the sum of the ROM in all six directions.

### *Sociodemographic data and comorbidities*

Sociodemographic data were collected through specific questions and comorbidities in the Self-Administered Comorbidity Questionnaire (SCQ) (19).

## Analyses

### *Descriptive statistics, treatment effects*

Descriptive statistics were calculated for baseline characteristics. Effect sizes (ES) for the primary outcome of NASS pain + disability and the secondary outcomes (NASS pain, NASS disability, SF-36 mental health, and total active cervical ROM) were determined by dividing the mean change between baseline and discharge by the standard deviation of the baseline score (25). ES over 0.30 are generally considered clinically meaningful unless instrument-specific studies have provided more reliable results for the minimal clinically important effects (26). Significance of changes were tested by t-tests for dependent samples of symmetrically or normally distributed data or by Wilcoxon signed-rank tests for not symmetrically distributed data.

### *Multivariate regression*

The primary dependent variable in linear regression models was the change score of the NASS pain + disability scale (12). In further linear regression modelling, the separated NASS pain scale and NASS disability scale were dependent variables.

Independent variables were selected from the collected variables to cover the International Classification of Functioning, Disability and Health (ICF) components function (physical function and mental function), activity and participation, and personal factors (27). A further criterion for co-variate selection was the presence of associations with treatment outcomes in previous predictor studies of musculoskeletal health conditions (14, 15, 28). Furthermore, range of motion was added as a co-variate because improvement of range of motion was a treatment goal (12), and previous studies showed an association of cervical spine ROM to pain and disability (29). The total number of co-variables was limited to 10, as 10 cases per co-variate are needed for finite models and sufficiently valid estimates of the regression coefficient (30).

The independent variables were sex, age, living with a partner, education level, number of comorbidities, SF-36 mental health baseline, SF-36 mental health mean change, total active cervical ROM, and change of total active ROM. In addition, all models were adjusted for the baseline score of the corresponding NASS scale, of which the change in score was the dependent variable. In order to adjust for any confounding, all listed co-variables were kept in the models, irrespective of whether their correlation was statistically significant or not. Multivariate partial correlations were thus determined and adjusted for all other included potentially confounding co-variables (31). The overall explained variances (%) were calculated to quantify the fit of the regression models.

For missing values of single co-variables, the mean imputation method was used (i.e. missing values were replaced by the mean of the valid values within each independent variable). We assumed missing values were due to random processes. This assumption is supported by 97% completeness of the SF-36 mental health scale at baseline and 98% at follow-up, despite patients generally regarding questions about mental health as more sensitive compared to questions about physical health. The frequency of missing values in the other co-variables ranged from 0% (sex, age, baseline scores of the NASS scales) to a maximum of 14% (education).

Statistical analyses were calculated using SPSS 25.0 for Windows. ES were calculated with Microsoft Excel 2010.

## Results

Participant characteristics and baseline scores

The sociodemographic characteristics of the 112 patients who were included from March 2006 to June 2012 are summarized in Table 1. The mean patient age was 59.7 years (SD: 10.8), and a majority were female (71%). Approximately 40% had three or more comorbidities and only 12% had no comorbidity. Half of the patients (50%) graduated from high school, while the others had lower degrees of education.

Table 1  
Characteristics of the study population ( $n = 112$ )

Characteristic	
Female, $n$ (valid %)	79 (70.5)
Age (years), mean (SD)	59.7 (10.8)
Living with a partner, $n$ (valid %),	68 (69.7)
Missing, $n$	12
Education, $n$ (valid %)	
Basic school	10 (10.4)
Vocational training	38 (39.6)
High school	18 (18.8)
Technical college	12 (12.5)
University	18 (18.8)
Missing, $n$	16
Comorbidities, $n$ (valid %)	
None	12 (12.1)
1	20 (20.2)
2	27 (27.3)
3	22 (22.2)
$\geq 4$	18 (18.1)
Missing, $n$	13
SD: standard deviation.	

## Outcome

The patients significantly improved in all outcomes: NASS pain + disability (ES = 0.56,  $p < 0.001$ ), NASS pain (ES = 0.67,  $p < 0.001$ ), NASS disability (ES = 0.41,  $p < 0.001$ ), SF-36 mental health (ES = 0.45,  $p < 0.001$ ), and total active cervical ROM (ES = 0.39,  $p < 0.001$ ) (Table 2).

Table 2  
Outcome scores ( $n = 112$ )

	Entry		Discharge		Entry $\diamond$ Discharge ES	$p$ -value
	Mean	SD	Mean	SD		
NASS						
pain + disability	2.80	0.71	2.40	0.68	0.56	< 0.001
pain	4.30	1.12	3.56	1.15	0.67	< 0.001
disability	2.41	0.74	2.11	0.70	0.41	< 0.001
SF-36 mental health	64.7	19.5	73.5	15.5	0.45	< 0.001
Total active ROM ( $^{\circ}$ ) *	236.1	44.5	253.6	40.6	0.39	< 0.001
*Total active ROM: sum of range of motion of cervical lateral flexion (both sides), cervical rotation (both sides), neck flexion, and neck extension. NASS: North American Spine Society questionnaire (1 = best health; 6 = worst health); SF-36: Short Form 36 questionnaire (0 = worst health; 100 = best health); ES: effect size.						

## Multivariate Regression Analysis

The second regression model analysed the change in the NASS disability scale as the dependent variable and explained 24.7% of the variance (Table 4). Worse NASS disability at baseline (partial, adjusted correlation: 0.42,  $p < 0.001$ ), greater age (0.25,  $p = 0.010$ ), and greater total active range of motion at baseline (0.25,  $p = 0.012$ ) were significantly correlated with improved NASS disability. The improvement of total active range of motion correlated less with disability (0.19) and only as a trend ( $p = 0.052$ ).

Table 4  
Multivariate regression of change in NASS disability ( $n = 112$ )

Covariate	Change R <sup>2</sup>	Change F-value	Regression coefficient	p-value	Bivariate correlation	Partial correlation
Constant			-1.891	< 0.001		
NASS disability baseline	0.161	2.248	0.264	< 0.001	0.37	0.42
Age	0.051	0.557	0.010	0.010	0.14	0.25
Active ROM* baseline	0.049	0.516	0.003	0.012	0.04	0.25
Active ROM* change	0.029	0.150	0.003	0.052	0.01	0.19
SF-36 mental health, change	0.015	-0.116	0.005	0.162	0.19	0.14
SF-36 mental health, baseline	0.011	-0.192	0.003	0.231	-0.10	0.14
Education	0.004	-0.317	-0.024	0.443	-0.05	-0.08
Marital Status (1 = alone; 2 = with partner)	0.002	-0.358	0.048	0.573	0.08	0.06
Gender (0 = female; 1 = male)	0.000	-0.398	-0.018	0.832	0.05	-0.02
Comorbidities	0.000	-0.399	0.006	0.842	0.16	0.02
Model total	0.247	3.319		< 0.001		
* Active ROM: sum of range of motion of cervical lateral flexion (both sides), cervical rotation (both sides), neck flexion, and neck extension. Positive regression coefficients for change scores represent positive associations. NASS: North American Spine Society questionnaire; SF-36: Short Form 36 questionnaire.						

In the first regression, the change in the NASS pain+disability scale was modelled with the 10 co-variates explaining 27.3% of its variance (Table 3). Positive and statistically significant correlations obtained higher NASS pain+disability baseline scores (partial, adjusted correlation: 0.41,  $p < 0.001$ ). Furthermore, greater age (0.22,  $p = 0.024$ ), greater total active range of motion at baseline (0.21,  $p = 0.033$ ), greater change in SF-36 mental health (0.20;  $p = 0.047$ ), and greater change in total active range of motion (0.20,  $p = 0.048$ ) were correlated with greater improvement in pain and disability.

Table 3  
Multivariate regression of change in pain + disability ( $n = 112$ )

Covariate	Change R <sup>2</sup>	Change F-value	Regression coefficient	p-value	Bivariate correlation	Partial correlation
Constant			-1.890	0.001		
NASS pain + disability baseline	0.151	2.209	0.281	< 0.001	0.38	0.41
Age	0.038	0.312	0.009	0.024	0.08	0.22
Active ROM,* baseline	0.034	0.228	0.002	0.033	0.004	0.21
SF-36 mental health, change	0.029	0.140	0.007	0.047	0.22	0.20
Active ROM,* change	0.029	0.132	0.003	0.048	0.05	0.20
SF-36 mental health, baseline	0.024	0.030	0.005	0.072	-0.09	0.18
Education	0.018	-0.093	-0.050	0.121	-0.16	-0.15
Gender (0 = female; 1 = male)	0.006	-0.336	-0.079	0.365	-0.02	-0.09
Marital Status (1 = alone; 2 = with partner)	0.003	-0.406	0.053	0.546	0.09	0.06
Comorbidities	0.002	-0.410	0.018	0.560	0.17	0.06
Model total	0.273	3.784		0.000		
* Active ROM: sum of range of motion of cervical lateral flexion (both sides), cervical rotation (both sides), neck flexion, and neck extension. Positive regression coefficients for change scores represent positive associations. NASS: North American Spine Society questionnaire; SF-36: Short Form 36 questionnaire.						

Modelling pain relief in the NASS as the dependent variable in the third model explained 25.4% of the variance (Table V). Only greater NASS pain at baseline was statistically significantly correlated with pain relief in the NASS (partial, adjusted correlation: 0.36,  $p < 0.001$ ). The second highest adjusted partial correlation was found for change in SF-36 mental health, but this correlation was not significant (0.18,  $p = 0.065$ ).

Table 5  
Multivariate regression of change in NASS pain ( $n = 112$ )

Covariate	Change R <sup>2</sup>	Change F-value	Regression coefficient	p-value	Bivariate correlation	Partial correlation
Constant			-1.988	0.106		
NASS pain baseline	0.111	1.547	0.343	< 0.001	0.42	0.36
SF-36 mental health change	0.026	0.087	0.015	0.065	0.18	0.18
Education	0.023	0.038	-0.136	0.079	-0.25	-0.17
SF-36 mental health baseline	0.021	-0.006	0.010	0.095	-0.04	0.17
Gender (0 = female; 1 = male)	0.012	-0.173	-0.265	0.199	-0.09	-0.13
Comorbidities	0.009	-0.237	0.079	0.270	0.12	0.11
Active ROM,* change	0.004	-0.329	0.003	0.437	0.09	0.08
Age	0.003	-0.363	0.006	0.539	-0.05	0.06
Active ROM,* baseline	0.001	-0.390	0.001	0.655	-0.06	0.05
Marital Status (1 = alone; 2 = with partner)	0.001	-0.408	0.060	0.776	0.07	0.03
Model total	0.254	3.444		0.001		
* Active ROM: sum of range of motion of cervical lateral flexion (both sides), cervical rotation (both sides), neck flexion, and neck extension. Positive regression coefficients for change scores represent positive associations. NASS: North American Spine Society questionnaire; SF-36: Short Form 36 questionnaire.						

No significant correlations in any of the regression models were found for the covariates gender, education, marital status, comorbidities, and SF-36 mental health baseline.

## Discussion

This prospective cohort study of participants in a CNP-specific MBR identified various prognostic factors for improvements in pain and disability. Outcomes were measured by the the NASS questionnaire. Patients significantly improved in the NASS scales for pain + disability, disability, and pain, as well as in mental health and cervical spine ROM.

Older age, better ROM of the cervical spine at baseline, greater improvements in cervical spine ROM, and greater improvements in mental health were prognostic factors for improvement in pain + disability. Older age and better ROM at baseline were also significantly correlated with the disability-specific NASS scale,

whereas the association between improvement in ROM and improvement in disability was not significant ( $p = 0.052$ ).

Higher NASS baseline scores, reflecting more pain or disability of each dependent variable, were a strong predictor for better outcomes in all three regression models. This is a well-known phenomenon in studies of outcome predictors after multidisciplinary treatment of patients with chronic musculoskeletal pain (15, 32). A regression toward the mean may have contributed to these associations, as patients with very poor baseline scores have more room to improve on a closed scale when compared to patients with better relative baseline scores (33).

The better outcomes of older patients in this study support the effectiveness of MBR for CNP in patients above 60 years of age, since the mean age of participants was 60 years. This is an interesting and novel result, because the only large-scale randomized controlled trial (RCT) on neck-pain-specific MBR had a considerably lower mean age of 53 years, while the mean age of most studies on the effectiveness of MBR in low back pain is between 40 and 45 years (34).

This positive association between older age and better outcomes in neck pain patients is in contrast to some previous research. A cohort study in CNP patients who participated in an MBR after whiplash injury found a weak but non-significant association ( $p = 0.065$ ) of younger age and better outcome (15). Likewise, previous studies in low back pain patients after MBR showed a tendency for a worse outcome of older patients (32, 35, 36). One possible cause for the contrary result in the present study may be that older age is a neutral or negative predictor of beneficial outcomes in patients of the working age but not in a population with a mean age of 60 years. This explanation is supported by a study on outcome predictors of an exercise-based rehabilitation programme in CNP patients with a mean age of 65 years, which showed no association between age and outcome (11).

The improvement of cervical spine ROM in this MBR can be attributed to treatment lessons in stretching exercises and active neck muscle training, which both yielded improvement in cervical ROM in previous studies (37, 38). The association between improvements in cervical ROM and improvements in pain + disability supports the application of these therapies as essential components of active exercise therapy in an MBR.

Previous studies rarely considered clinical tests as prognostic factors of the outcome after comprehensive rehabilitation (39). To our knowledge, this is the first study to evaluate the association between improvement in cervical spine ROM and self-reported pain and disability. In a systematic review from 2019, a study in low back pain patients found a small positive correlation between trunk muscle endurance at baseline and pain intensity one year after a six-week restoration programme that consisted of two-hour treatments, twice per week. That study found no correlation between aerobic capacity or abdominal muscle endurance and improvement in pain intensity. Another study evaluated an intensive three-week multidisciplinary rehabilitation programme in low back pain patients (40). It found no association between baseline back muscle endurance or physical capacity and outcomes in pain or

physical functioning. None of these studies looked for correlations of changes in these clinical tests to the outcomes.

In the present study, the correlation between mental health and improvement in NASS pain + disability was significant. This positive longitudinal pain-depression association is supported by previous research. A recent comparison of six cohorts treated for specific chronic pain conditions found strong positive associations between improvements in mental health and improvements in pain for patients with neck pain after whiplash, knee osteoarthritis, low back pain, fibromyalgia, and lipoedema, as well as a weak correlation between change in mental health and shoulder arthroplasty (28). In our study, the correlation was smaller compared to the correlation reported for whiplash patients (0.22 versus 0.52). A possible reason is the better baseline status in mental health in the present study (SF-36 mental health baseline 64.7 versus 52.5); correlations between improvements in mental health and improvements in pain tend to be weaker for patients with better baseline mental health status (28).

One strength of this study is the generalizability to similar MBR programmes, due to its naturalistic design. In contrast to most RCTs, this research applied no artificial restrictions to participation or adaptations of the intervention, which is routinely reimbursed by German statutory health insurance. Another strength is the application of a primary outcome measure that is reliable and valid while covering the ICF components of body function, activity, and participation (27). In addition, the independent variables covered the ICF components of mental function (SF-36 mental health), physical function (range of motion, baseline NASS score), activity and participation (baseline NASS score), and personal factors (age, gender, education).

In this study, differences in baseline comorbidities or mental health were not associated with differences in improvement in pain or disability. This missing association may be a result of the thorough interdisciplinary assessment preceding the recommendation of MBR, which excluded patients who had severe mental illness or severe comorbidities and were less likely to benefit from this MBR.

A limitation of this study is the relatively low level of explained variance. This indicates that some important modifying factors of pain and function were not assessed. Accordingly, the co-variables do not provide precise prediction of the outcomes of pain and disability. Adding additional potential cognitive-behavioural factors as predictors (such as coping styles or self-efficacy) may have increased the R-squared value (39). Nonetheless, this does not impact the conclusions drawn from the statistically significant correlations. A further limitation is the absence of a control group. This limits the interpretation of the reported effect sizes, but the non-controlled design was effective for the primary aim of identifying prognostic factors of the outcomes.

## Conclusions

The associations between a greater improvement in pain and disability and the prognostic factors of older age, improvement in mental health, and improvement in cervical spine ROM allow important conclusions for clinical practice. They support the combination of physical and psychological treatment

components, because improvements in both physical health (represented by increased range of motion) and mental health were associated with better outcomes. Furthermore, the results suggest that older patients may improve more compared to younger patients. Further research should confirm the results and address additional cognitive-behavioural co-variables, such as coping styles and self-efficacy.

## Abbreviations

YLD Years lived with disability

CNP Chronic neck pain

MBR Biopsychosocial rehabilitation programme

ROM Range of Motion

CROM Cervical range of motion instrument

NASS North American Spine Society questionnaire

SF-36 Short Form 36

SCQ Self-Administered Comorbidity Questionnaire

ICF International Classification of Functioning, Disability and Health

## Declarations

### *Ethics approval and consent to participate*

All participants provided signed informed consent prior to study participation. At the time of data collection, ethical approval was not mandatory for observational studies that evaluate routine care. A later study at the day clinic with an almost identical burden to the patients was approved by the ethic committee at the medical faculty of the Ludwig Maximilian University Munich (Project-Number 632-16, accepted 24.Nov. 2016, Chairman Prof. Dr. W. Eisenmenger).

### *Consent for publication*

Not applicable

### *Availability of data and materials*

The data set is not available because patients did not consent to the use of their data in a public repository.

### *Competing interests*

The authors declare that they have no competing interests.

### *Funding*

There was no funding.

### *Authors' contributions*

MW: Study conception and design; major contribution to the interpretation of data; major contribution drafting and revising all parts of the manuscript.

JL: Acquisition of data; minor contribution to the interpretation of data; drafting all parts of the manuscript; minor contribution to the revision of the draft.

FA: Study design; Statistical analyses; major contribution to the interpretation of data; drafting methods section of the manuscript; major contribution to the revision of the draft.

All authors read and approved the final manuscript.

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