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The Impact of Spinal Problems on the Health Status of Patients

Have We Underestimated the Effect?

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Study Design. A prospective study of 17,774 patients who consulted spine centers in which the impact of spinal disorders and comorbidities on physical functional status were evaluated.

Objectives. To quantify the effect spinal diagnoses have on patients' physical functional status (SF-36 Physical Component Summary [PCS] score) compared with other common conditions and to quantify the effects of comorbidities on physical functional status in spine patients.

Summary of Background Data. The burden of spinal conditions on a patient's function and the role that comorbidities play in this affliction are poorly quantified in the literature.

Methods. Data from the Health Survey Questionnaire were prospectively gathered through the National Spine Network, a nonprofit consortium of spine-focused practices. Each patient's SF-36 score was summarized into a single PCS score. The correlation between diagnosis and comorbidity and PCS score was assessed using multivariate linear regression.

Results. The study patients were a mean of 47.5 years of age, 54.7% were female, 52.3% had lumbosacral diagnoses, and 82.0% had had 3 or more months of pain. The population had a mean PCS score of 30.4 ± 9.95 (SD) compared with 50.0 ± 10.00 for the general United States population. The more comorbidities in a patient, the lower the PCS score (Spearman rank correlation = −0.27). The five comorbid conditions that lowered the PCS the most included congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), renal failure, rheumatoid arthritis, and lupus (all $P < 0.001$). In multiple linear regression analysis, age, gender, diagnosis, and comorbidity explained 12.1% of the variance in PCS score.

Conclusions. The PCS score is greatly affected in patients with spinal problems. The study population's PCS (30.4) was lower or similar to the PCS for patients with other illnesses reported in the literature: CHF (31.0), COPD (33.9), SLE (37.1), cancer (38.4), primary total hip arthroplasty (29.0), primary total knee arthroplasty (32.6), and glenohumeral degenerative joint disease (35.2). Further, the presence of comorbidity in spine patients adds to the burden of spinal conditions on functional status. [Key words: comorbidity, functional status, National Spine Network, physical composite summary, Short Form-36, spinal disorder] **Spine 2000;25:1509–1514**

The general population and the medical community fully recognize that spinal conditions have an enormous economic impact both on the world's workforce and on its health care system.[7,10,15,20,23] However, although the societal impact of spinal conditions is well documented, very little is known about the impact of spinal conditions on the patient's physical function relative to the impact of other common conditions.

Among 20- to 50-year-old persons, back pain is the most costly musculoskeletal problem and the most expensive industrial injury.[7,15,20,23] In the United States, it is second only to the common cold as the reason for physician visits and the third ranking reason for surgery.[2] Although the functional status of certain subsets of spinal patients has been studied by others, the breadth of this illness in a large population of patients with diverse spinal diagnoses has not been previously established.[4,6,9,11,16] Furthermore, many patients who experience a spinal disorder also have other illnesses. Although comorbidity may diminish a patient's functional status, the role that comorbidities play in patients with spinal problems is not well understood.

The paucity of information in this area of research spawned the current study, which had two goals: to quantify the impact of spinal problems on physical functional status (a patient's physical morbidity), and to understand and quantify the effect of comorbidities on physical functional status in a population of spine patients. Well-accepted measures of pain and function will be used to grasp the burden of this condition.

Methods

Study Design. This is an observational study of 17,774 patients from 25 centers that comprise the National Spine Network (NSN). The NSN is a nonprofit organization with a nationwide membership that includes academic institutions, hospitals, private physician practices, and individual physicians who treat patients with back and neck problems. The NSN was formed as a mechanism to foster longitudinal research into the care of spine patients by spine specialists.

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Measures.

The Initial-Visit Questionnaire . The data from this study were collected through use of the NSN's initial visit Health Survey Questionnaire. The patient completed questions concerning spine symptoms, demographics, work, and the standardized, self-administered Medical Outcomes Trust's SF-36 Health Status Questionnaire.[27] The majority of patients reported that they completed the entire NSN questionnaire, including the SF-36, in less than 20 minutes. The treating physician completed questions about the spine symptoms, diagnostic testing, specific spinal diagnosis, comorbidity, and treatment plans.

The SF-36 Health Status Questionnaire. The functional status of the patients was measured by the SF-36 Health Status Questionnaire, administered at each NSN center. Physical functional status is a measure that captures how patients perceive their level of physical morbidity and its effects on their everyday lives. The eight scales of the SF-36 are general health perceptions (GH), physical function (PF), general mental health (MH), role function as limited by physical problems (RP), role function as limited by emotional problems (RE), bodily pain (BP), vitality (VT), and social function (SF). The *z* scores for each of the eight subscales were calculated by subtracting general US population means and dividing by the corresponding standard deviations. These were then used to compute a Physical Component Summary (PCS) score using the equation provided by the Medical Outcomes Trust.[26]

$$\begin{aligned}\text{PCS} = 50 + \{[&(\text{PF\_Z} \times 0.42402) + (\text{RP\_Z} \times 0.35119)\\ &+ (\text{BP\_Z} \times 0.31754) + (\text{GH\_Z} \times 0.24954)\\ &+ (\text{VT\_Z} \times 0.02877) + (\text{SF\_Z} \times -0.00753)\\ &+ (\text{RE\_Z} \times -0.19206) + (\text{MH\_Z} \times -0.22069)]\ 10\}.\end{aligned}$$

The PCS is an aggregate score that quantifies how patients perceive the impact of their condition on the physical aspects of their daily living, a measure of each patient's physical morbidity. A main reason the authors chose the PCS as a dependent measure instead of the eight SF-36 subscales is that it greatly reduces the number of statistical analyses, without missing clinical differences.[26] Further, the interpretation of a single physical summary score is more straightforward and uncomplicated than the interpretation of any one of the eight subscales or all eight collectively.[26] When compared with SF-36 scales, PCS scores have greater or equal reliability and have many more scale levels, which creates more statistical power in detecting differences in physical health.[26]

To compute a PCS score for a patient requires a score for each of the eight subscales. If a patient answered less than half of the questions in one or more of the eight subscales, no PCS score could be calculated.[26] The original data set for this study contained 21,379 patients who partially or fully completed the NSN's initial visit Health Survey Questionnaire. In this group, 3,525 patients answered less than half of the SF-36 questions in one or more of the eight subscales. Thus, PCS scores could be calculated on 17,854 patients from the original 21,379-patient population. The date of birth was absent on the questionnaire for 80 of these patients. Thus, the current study used 17,774 patients from the original population. Data were not collected on the percentage of patients who were given the initial visit Health Survey Questionnaire who then partially or fully completed it.

Comorbidity. All information regarding comorbidities in the study population was provided by the physician's section of the NSN questionnaire. This section included the following list of 23 comorbidities: anemia; angina; arthritis; asthma; leukemia, lymphoma, or solid cancer; metastatic or multiple cancers; congestive heart failure (CHF); chronic obstructive pulmonary disease (COPD); diabetes; hemophilia; hepatitis; hypertension; liver disease; lupus; malnutrition; obesity; osteoporosis; peptic ulcer; peripheral vascular disease; renal failure; seizures; smoking; and urinary tract infection. Furthermore, on 2711 questionnaires, additional conditions were written in under the heading "other comorbidities." A subset of the coauthors, including two spine surgeons (WA and JW) and a medical student (JF), coded each of these 2711 write-ins using the International Classification of Diseases (9th rev.) Clinical Modification (ICD-9-CM).[13]

According to a classification scheme based loosely on the Cumulative Illness Rating Scale, each of the individual comorbidities was then categorized into one of the following 13 organ systems: cardiac; endocrine-metabolic; eyes, ears, nose, and throat; hepatic; lower gastrointestinal; musculoskeletal integumentary; neurologic; genitourinary; psychiatric; renal; respiratory; upper gastrointestinal; and vascular.[17] Two categories were added: neoplasms and substance abuse.

Three essential data points could be calculated for the 17,774 patients: the mean PCS score for the population; the correlation between number of comorbidities present and the PCS score; and the effect of specific comorbidities on PCS score.

Statistical Analysis. Multiple linear regression analyses were performed to relate functional status to comorbidities. The dependent variable in every model was the PCS score, transformed using the natural log (ln) to achieve an approximately normal distribution. The pool of independent variables included all those comorbidities that were present in at least 30 patients.

A regression model was fit to each of the 15 subsystems in the comorbidity index using ln(PCS) as the dependent variable. Age, sex, diagnosis class (as outlined in the NSN clinician questionnaire), and all comorbidities that fell into that particular subsystem according to the index were used as independent variables for each subsystem model. A best-fit model for each subsystem was calculated based on explained variance. To create a single regression model, every independent variable found to be a significant predictor in each of the 15 best-fit subsystem models was pooled. Again explained variance were used to calculate the single best-fit model. The final regression model was based on all 17,774 patients. Spearman rank correlation coefficients were used to quantify the correlation between PCS and the number of comorbidities per patient. All statistical analyses were performed by computer (Stata statistical software; Stata Corp., College Station, TX).

■ Results

Demographic

Demographic characteristics of the 17,774-person study population are presented in Table 1. The study patients had a mean age of 47.5 years, 54.7% were female, 84.2% were white, 82.0% had three or more months of

Table 1. Population Profile (N = 17,774)

Characteristic	%	n
Age (years)		
Mean ± SD: 47.5 ± 15.4		
Range: 17 to 98		
Male	54.7%	(9716)
White	84.2%	(14,958)
Married	60.0%	(10,662)
College education or beyond	35.4%	(6294)
Hired attorney	14.7%	(2614)
Receiving compensation	19.0%	(3383)
Patients with 3 or more months of pain	82.0%	(14,570)
Patients with a lumbosacral diagnosis	52.3%	(9296)

pain symptoms, and 52.3% had a lumbosacral diagnosis.

Clinical

To illustrate the population's clinical characteristics, Table 2 presents the 10 most common spinal diagnoses. In Table 3, comorbidities that appear in 100 or more of the patients are listed.

Table 2. Specific Diagnosis Profile* (N = 17,774)

Diagnosis	%	n
Herniated disc	19.2	(3410)
Spinal stenosis	13.1	(2337)
Degenerative spondylosis (aging)	12.9	(2294)
Facet arthropathy	9.1	(1610)
Chronic pain syndrome	6.1	(1081)
Chronic sprain/strain	4.4	(789)
Idiopathic scoliosis	4.0	(718)
Acute sprain/strain	3.5	(621)
Spondylolysis	3.3	(588)
Traumatic fracture	3.1	(556)

* Included in this table are the 10 most common diagnoses.

Table 3. Frequency of Comorbidities* (N = 17,774)

	Patients With This Condition and Possibly Others	
Comorbidity	%	n
Smoking	16.8	(2987)
Hypertension	12.2	(2167)
Obesity	7.6	(1345)
Diabetes	4.0	(717)
Arthritis	2.8	(498)
Peptic ulcer	2.5	(446)
Asthma	2.1	(365)
Angina	2.0	(349)
Leukemia, lymphoma, or solid CA	1.7	(299)
Depression	1.5	(260)
Osteoporosis	1.4	(245)
Congestive heart failure	0.76	(135)
Hypothyroidism	0.73	(130)
Peripheral vascular disease	0.70	(125)
COPD	0.66	(118)

* Included in this table are only those comorbidities found in greater than 100 patients.
CA = cancer; COPD = chronic obstructive pulmonary disease.

Functional Status

Table 4 presents summary results for the SF-36 questionnaire. The three SF-36 subscales that best detect a patient's physical impairment—role-physical, bodily pain, and physical functioning—are the three subsets that differ most profoundly from the US general population norm.[13] This study population had a mean PCS score of 30.4 ± 9.95; the mean PCS score for the general US population is 50.0 ± 10.00.[26] The maximum scored attainable on the scale is 77; the minimum is 2.

The population was stratified by the duration of symptoms and by the location of the primary spinal diagnosis (data not shown). Patients with symptoms for 3 months or less (PCS = 31.4) had scores similar to those of patients with symptoms for 3 or more months (PCS = 30.2). Patients with lumbosacral diagnoses had a mean PCS score of 28.9, whereas patients with a cervical or thoracic diagnosis had a PCS score of 32.1.

Comorbidity

The study population was stratified retrospectively by the number of comorbidities present in each patient (Figure 1). The age- and sex-adjusted mean PCS scores for each strata are shown in this figure ($P_{\text{trend}} < 0.001$).

These data illustrate that comorbidity is associated with a lower PCS score and increasing numbers of comorbidities are associated with decreasing PCS scores (Spearman rank correlation = −0.27). In multiple linear analysis, age, gender, diagnosis, and comorbidity explained 12.1% of the variance in PCS score.

Table 5 presents the age- and sex-adjusted PCS scores of patients with and without certain comorbidities. The most debilitating comorbidities, as measured by the PCS scale, include CHF, COPD, renal failure, rheumatoid arthritis, lupus, peripheral vascular disease, osteoporosis, metastatic cancer, diabetes, angina, asthma, arthritis, obesity, peptic ulcer, hypertension, leukemia, lymphoma and solid cancer, smoking, and depression (all with $P < 0.001$). Although there is a paucity of literature in this area, the cardiac findings are consistent with the findings of others.[14]

In this population, 46.6% of the patients had at least one other nonspinal illness. To determine whether spinal conditions or comorbidity was driving the low PCS score, data of patients with only a spinal condition and no comorbidity (data not shown) were analyzed. The mean PCS score of such patients with no comorbidity was 31.6 (9459 patients or 53.2% of the population). It is likely that the spinal diagnosis, in itself, is mostly responsible for the significant functional disability, expressed by low PCS scores.

■ Discussion

It is well recognized that society bears a heavy economic burden from those with spinal conditions. But what has not been apparent is the measurable extent to which this population is functionally impaired, regardless of duration or location of symptoms. Physicians who treat spine

Table 4. SF-36 Scores of Study Population

SF-36 Scale	Mean ± SD for NSN Patients*	Mean ± SD for General U.S. Population†	Deviation from U.S. Norm	95% Confidence Interval
Role—physical	18.1 ± 32.2	81.2 ± 33.9	−63.1	[61.7, 64.5]
Bodily pain	29.9 ± 22.2	75.5 ± 23.6	−45.6	[44.6, 46.6]
Physical functioning	41.8 ± 28.9	84.5 ± 22.9	−42.8	[41.8, 43.8]
Social functioning	50.9 ± 30.1	83.6 ± 22.4	−32.7	[31.7, 33.7]
Role—emotional	59.6 ± 44.3	81.3 ± 33.0	−21.7	[20.2, 23.2]
Vitality	39.7 ± 23.0	61.1 ± 20.9	−21.4	[20.5, 22.2]
Health perception	60.9 ± 23.0	72.2 ± 20.2	−11.3	[10.5, 12.2]
Mental health	63.6 ± 21.8	74.8 ± 22.4	−11.3	[10.3, 12.2]
Physical Component Summary	30.4 ± 10.0	50.0 ± 10.0	−19.6	[19.2, 20.0]

* n = 17,774.
† n = 2474.[13]

patients and the healthcare systems in which these physicians work must realize that there is a significant physical burden that these patients endure.

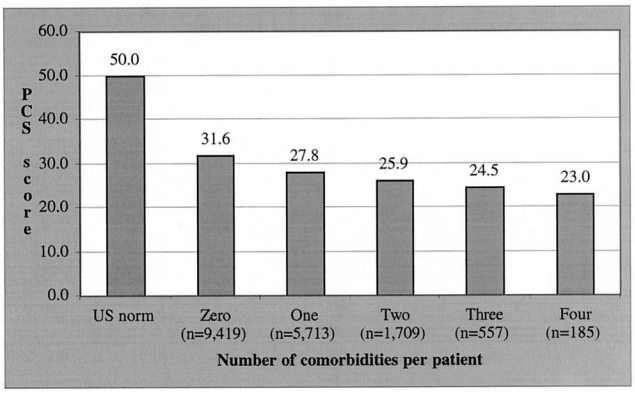

Figure 1. Physical component summary score per number of comorbidities. N=17,774. All means are age- and sex-adjusted. *P* (trend) < 0.001. PCS = physical component survey.

Scoring 2.0 standard deviations lower than the US norm, the 17,774 NSN spinal patients have significantly more physical morbidity than does the US population in aggregate ($P < 0.00001$).[26] These findings are consistent with others' findings. Patrick et al[21] studied 427 patients with sciatica; their mean PCS score was 30.8. Lorish et al[18] performed microdiscectomies on patients with sciatica; their mean PCS score was 32.8 before surgery. Hozack et al[12] studied 41 patients who had a lumbar laminectomy for radiculopathy (39 had a herniated disc) in whom 6–8 weeks of conservative treatment had failed; their mean PCS score was 29.8 before surgery.

Figure 2 compares the mean PCS scores of patients in the current study with those of patients with other significant common conditions. The data for the orthopedic patients were compiled from studies of patients before surgical intervention for hip, knee, and shoulder conditions.[5,12,22] The data for the patients with CHF was collected by Thalji et al[25] by telephone calls and mailings randomly disseminated across the US population. The

Table 5. PCS Scores for Spinal Patients with Comorbidity (N = 17,774)

Comorbidity in Spinal Patient	# of Patients With This Condition	Mean PCS of Pts With at Least This Comorbidity*	Mean PCS of Pts Without This Comorbidity*	Difference in PCS Between Pts With and Pts Without This Comorbidity	95% Confidence Interval
CHF	135	21.7	29.4	−7.7	[−7.4, −8.0]
COPD	118	22.5	29.4	−6.9	[−6.6, −7.3]
Renal failure	52	22.6	29.4	−6.8	[−6.3, −7.3]
Rheumatoid arthritis	41	22.7	29.4	−6.8	[−6.0, −7.4]
Lupus	48	22.9	29.4	−6.6	[−6.0, −7.1]
Peripheral vascular disease	125	23.9	29.4	−5.6	[−5.2, −5.9]
Osteoporosis	245	24.0	29.5	−5.5	[−5.2, −5.7]
Metastatic CA	86	24.2	29.4	−5.3	[−4.8, −5.7]
Diabetes	717	24.4	29.6	−5.2	[−5.1, −5.3]
Angina	349	24.4	29.5	−5.1	[−4.9, −5.3]
Asthma	365	25.1	29.5	−4.4	[−4.2, −4.6]
Arthritis	498	25.2	29.5	−4.3	[−4.2, −4.5]
Obesity	1345	25.6	29.7	−4.1	[−4.0, −4.2]
Peptic ulcer	446	25.5	29.5	−4.0	[−3.9, −4.2]
Hypertension	2167	26.6	29.8	−3.2	[−3.2, −3.3]
Leukemia, lymphoma, or solid CA	299	26.3	29.4	−3.1	[−2.9, −3.3]
Smoking	2987	26.9	29.9	−3.0	[−2.9, −3.1]
Depression	260	27.5	29.4	−1.9	[−1.7, −2.1]

* All means are age- and sex-adjusted.
CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; CA = cancer.

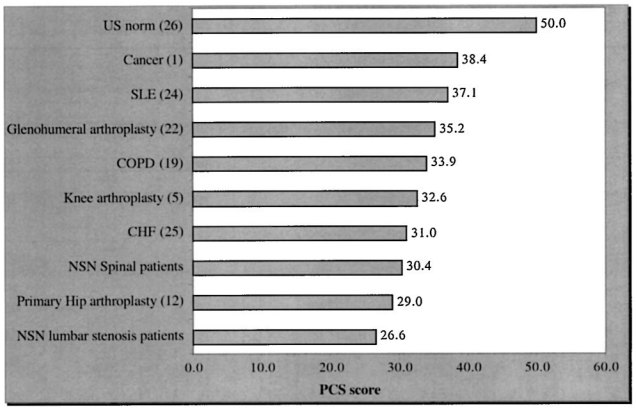

Figure 2. PCS scores across various conditions (reference number in parentheses). PCS = physical component summary; COPD = chronic obstructive pulmonary disease; CHF = congestive heart failure.

other nonorthopedic data were compiled from studies of patients with COPD, lupus, or various forms of cancer.[1,19,24] The mean PCS of the entire study population was 30.4; for primary hip arthroplasty before surgery, 29.0; for primary knee arthroplasty before surgery, 32.6; and for shoulder degenerative joint disease before surgery, 35.2. Further, the responses to the telephone and mail survey of Thalji et al[25] showed that the PCS was 31.0 for patients with CHF. The PCS for patients with COPD in Mahler and Mackowiak[19] was 33.9, for patients with lupus in Stoll et al[24] was 37.1, and for patients with various forms of cancer in Anderson et al[1]was 38.4. These data show that spinal problems and other significant orthopedic diseases have similarly profound impacts on patients, and the current study population was more likely to be physically impaired than are most patients with other significant nonorthopedic disease.

These data indicate that physicians and the healthcare system must realize that the spinal patient's physical burden is often similar to or greater than that endured by their patients with CHF, COPD, cancer, or orthopedic disorders. It must also be realized that the presence of comorbidity modestly exacerbates this already low level of physical functioning.

A major strength of this study is that it used the unique resource of the National Spine Network to collect data from 25 locations across the United States. The data are based on a large population of 17,774 ethnically diverse patients who had a wide variety of spinal conditions. The size of the data set and the broad spectrum of the data it contains allowed us to elucidate, with detail and by controlling for a number of confounding factors, the roles that spinal conditions and comorbidity play in patients.

A main limitation of this study involves the reporting of comorbidities. Each patient's comorbidities were recorded by a spine specialist. There is no mechanism to ensure that each spine specialist in each of the 25 NSN sites extracted the same degree of medical history from each patient. Thus, it is likely that some of the comorbidities were underreported.

Another limitation of the current study is that these patients were from spine centers, not primary care practitioners' offices. Thus, NSN patients represent a subgroup of all spinal patients. This may limit the generalizability of the results to patients who are seen by spine specialists. The PCS data presented in Figure 2 represent another limitation. The studies used (except for the patients with CHF) dealt with specialists' patients because, similar to the spine patients, these studies included only patients symptomatic enough to see a specializing physician. But it is difficult to determine whether the patients in each study were as representative of their respective diseases as the spine patients were of back conditions. The size of each of these comparative study populations was smaller than that in the current study and the criteria for entry into the studies also differed. For instance, each orthopedic study included only presurgical patients, whereas there was a spectrum of treatment methods used in the current spinal population. Further, the data on the patients with CHF were from mail and telephone surveys distributed randomly throughout the US population. All other patients in Figure 2 were symptomatic enough to see a physician, which may not hold true for the mail and telephone respondents. That is, the NSN patients may be more ill than other spinal patients, whereas those with CHF who were contacted by mail or telephone may be healthier than other patients with CHF.

A main implication of the current study involves the expectations of both patient and physician regarding the outcome of care. Because the baseline physical functional impairment of spinal patients is so low (PCS = 30.4), recovering to a level of functioning consistent with the general US population (PCS = 50.0) is unlikely, even if the patient has no comorbidity. This indicates that physicians and patients may have to redefine "success" with respect to outcomes from various interventions offered. It must be realized that in some cases no treatment or at least a lesser treatment may have had the same effect as a more risky and costly intervention.[8]

For the near-majority of patients with comorbidity, there is an additional concern regarding expectations of care. When undertaking a particular spinal intervention, it is important that the physician and patient understand that even if the intervention is fully successful, the comorbidity will remain. A patient's postsurgical physical functioning is likely to be lower than that of a similar patient who had no comorbidity. Again, success may need redefinition.

What does this mean? To the authors it is an indication that, if a generic instrument such as the SF-36 is to be used to follow up on the health status of patients who have back conditions, it must be with the understanding that these patients are substantially impaired physically. Further, the attempt to use such generic instruments across disciplines is important and should not be abandoned. The SF-36 is sensitive to change in many musculoskeletal conditions, including patients with diagnosis of herniated disc or spinal stenosis.[3] It is, however, im-

portant that in using these instruments, the physician understand the scale that should be used to measure success. Patients with spinal conditions may aspire to achieve age- and sex-adjusted normal subscale values, but this is not the rule and the clinician cannot be held to such a standard. Further, in the absence of longitudinal data, functional status scores can deceive the physician into thinking the treatment has been either very successful or a complete failure. Knowing that many patients are significantly disabled by spine problems allows clinicians to set more realistic expectations for their patients and themselves.

Much more work is needed to understand why this population of patients is so different from the norm as measured by the well-accepted generic health status instrument, the SF-36. Some of the future research efforts should be geared toward a better understanding, while reassessing the diagnostic and therapeutic approaches to these patients.

■ Key Points

- Physical functional status is significantly lower in patients with spinal disorders in the United States than in the general population.
- Patients with spinal disorders have worse physical functional status scores than those with most other disease conditions.
- Comorbidities in patients with spinal disorders are associated with lower physical functional status.

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