The Dimensions of Health Outcomes: A Cross-Validated Examination of Health Status Measurement

JEFFREY H. BROWN, MD, LEWIS E. KAZIS, ScD, PATRICIA W. SPITZ, RN, PAUL GERTMAN, MD, JAMES F. FRIES, MD, AND ROBERT F. MEENAN, MD, MPH

Abstract: Two independently developed patient outcome measurement instruments were administered to forty-eight subjects with rheumatoid arthritis using a random cross-over design. The independent estimates of physical disability and pain are highly correlated. Each instrument displayed highly significant relationships with global health, providing evidence for convergent validity. The results demonstrate that health status is composed of at least three major dimensions: physical disability, psychological disability, and pain. (*Am J Public Health* 1984; 74:159–161.)

The chronic diseases affect the quality of life as well as the duration of life, and thus require for their assessment the ability to measure health status effectively.[1–9] Two independent instruments have recently been,[10,11] developed to assess patient outcome in arthritis and other chronic diseases the Health Assessment Questionnaire (HAQ), and the Arthritis Impact Measurement Scales (AIMS); both are self-administered. This study compares these instruments in a randomized crossover study, demonstrates convergent validity for the health status concept, and identifies major components of patient outcome.

Methods

Instrument Description

The HAQ disability and pain instruments consist of 21 questions grouped into nine components graded in an ordinal fashion from 0 to 3.* The AIMS instrument is composed of 49 items. The initial 45 items are summed into nine scales. Each scale is indexed from zero to ten (minimum to maximum disability).** The content of the two instruments overlaps by about 65 per cent. In all cases, however, the actual questionnaire items are different. Both instruments contain a single horizontal visual analog scale assessing the patient's perception of arthritis status, providing a "global health estimate."

Instrument Performance

Both instruments have undergone extensive validation.[10–13]*** All nine AIMS scales were highly correlated with physician produced estimates of health status, and specific scales correlated highly with standard measures of physical function.[13] Correlations of the HAQ battery against observed patient performance ranged from 0.47 to 0.88.[10,12]

Study Design

Forty-eight patients with rheumatoid arthritis were administered the two instruments by mail at an average 18-day interval in random order. Subjects were randomly selected from a community-based study group of 384 patients.[12] Scores for items, component scales, and aggregate scales of both instruments were calculated. The order of administration did not affect results. Factor analysis on both AIMS and HAQ scales focused on standard principal factor techniques with varimax rotation.[14]

Results

The study group was typical of rheumatoid arthritis in being predominantly White (89 per cent), female (83 per cent), and married (68 per cent), with an average age of 53 years. Forty-nine per cent had received more than a high school education; 43 per cent earned less than $15,000 per year, while 39 per cent earned more than $25,000.

The AIMS factor analysis identified three factors with distinct factor loadings (Table 1). The first factor has high loadings on each of the five AIMS scales with physical disability content; the second large loadings on the depression and anxiety scales; the third a single major loading on the pain scale. Factor analysis on the nine HAQ scales reveals two distinct factors. The first shows high loadings on the eight physical scales; the second a highly distinct loading on pain.

Thus, three principal dimensions of health status are assessed by the AIMS and HAQ instruments: physical disability, psychological disability, and pain. The common components show marked similarity in the variance which they explain (e.g., 13 per cent for AIMS "pain" versus 15 per cent for HAQ "pain"). The total variance explained is high, indicating the adequacy of the three and two factor models (Table 1).

Table 2 presents a combined factor analysis of the HAQ and AIMS scales. The five AIMS physical disability scales identified as having similar factor loading patterns have been grouped by computing an average score, labeled "AIMS disability," as have the eight disability components from the HAQ analysis. This combined analysis again indicates three distinct health status components. Factor 1 loads on both the HAQ and AIMS physical disability dimensions and explains 30 per cent of the variance in the model. Factor 2 loads on the two AIMS psychological scales, anxiety and depression,

*(1) dressing and grooming; (2) arising; (3) eating; (4) walking; (5) reach; (6) personal hygiene; (7) gripping and grasp; (8) activities; (9) pain.

**(1) mobility; (2) physical activity; (3) activities of daily living (ADL); (4) dexterity; (5) household activities; (6) pain; (7) social activity; (8) depression; (9) anxiety.

From the Multipurpose Arthritis Centers and the Departments of Medicine, Stanford and Boston Universities, and the Health Care Research Section, Boston University School of Medicine. Address reprint requests to: James F. Fries, MD, Department of Medicine, HRP Building, Room 109C, Stanford University, Stanford, CA 94305, or to Robert F. Meenan, MD, MPH, Boston City Hospital, ACC 3E-09, 818 Harrison Avenue, Boston, MA 02118. This paper, submitted to the Journal January 10, 1983, was revised and accepted for publication May 4, 1983.

***The AIMS instrument showed mean test re-test correlations for the nine scales ranging from 0.84 to 0.92, and the HAQ Disability Index 0.98.[12,13]

TABLE 1—Separate Factor Analyses of AIMS and HAQ Instruments Factor Loadings

AIMS Scales (N = 42)	Factor 1 ("Physical")	Factor 2 ("Psychological")	Factor 3 ("Pain")
Mobility	*.88*	−.01	−.18
Physical Activity	*.77*	.25	.29
Dexterity	*.71*	.23	.27
ADL	*.72*	−.06	.08
Household Activity	*.88*	.14	−.12
Social Activity	.48	.36	−.63
Pain	.35	.31	*.72*
Depression	.16	*.93*	.03
Anxiety	−.01	*.92*	.06
Variance by Factor (%)	39	23	13

HAQ Scales (N = 48)	Factor 1 ("Physical")	Factor 2 ("Pain")
Dress	*.85*	.09
Arise	*.81*	.22
Eat	*.73*	−.19
Walk	*.75*	.36
Hygiene	*.77*	.26
Reach	*.81*	.17
Grip	*.79*	.11
Activities	*.77*	.39
Pain	.10	*.91*
Variance by Factor (%)	55	15

TABLE 2—Combined Factor Analysis of HAQ and AIMS Instruments Factor Loadings

Scale Groups (N = 42)	Factor 1 ("Physical")	Factor 2 ("Psychological")	Factor 3 ("Pain")
HAQ Physical	*.85*	.02	.34
AIMS Physical	*.88*	.06	.37
AIMS Social	.69	.29	−.25
AIMS Anxiety	.03	*.94*	.08
AIMS Depression	.22	*.89*	.20
HAQ Pain	.15	.08	*.84*
AIMS Pain	.13	.19	*.87*
Variance by Factor (%)	30	26	26

TABLE 3—Correlation Matrix of Aggregated Scales

	HAQ Physical	AIMS Physical	HAQ Pain	AIMS Pain
AIMS Physical	0.91**			
HAQ Pain	0.30*	0.39**		
AIMS Pain	0.39**	0.43**	0.64**	
AIMS Psychological	0.23	0.25	0.19	0.31*

*Significant at the alpha = 0.05 level.
**Significant at the alpha = 0.01 level.

and explains 26 per cent of the variance. The two pain measures load on a third factor which explains 26 per cent of the variability. Thus, these three dimensions of health outcome explain a major percentage of the cumulative variance in self-reported global health status (82 per cent). In addition, the HAQ and AIMS estimates of physical disability and pain show nearly identical factor loadings (physical: .85 versus .88; pain: .84 versus .87).

The correlation (Table 3) between the HAQ and AIMS physical disability scales is .91 and that for the pain measures is .64, indicating that the two instruments measure similar constructs. The interdimensional correlations within the same instrument between physical disability and pain are decidedly lower, 0.43 and 0.30. The AIMS psychological measures show low correlations with the physical and pain measures of both AIMS and HAQ.

The relationships of the major HAQ and AIMS scale groups to global health estimates are shown in Table 4. Simultaneous regressions were run separately for each instrument. The physical, pain, and overall groupings of both HAQ and AIMS show high comparability. Further, the standardized beta coefficients indicate distinct and significant similarities for both the physical disability and pain estimates derived from the separate instruments.

Discussion

This study demonstrates that different outcome instruments developed independently at separate institutions measure similar dimensions of health status in a model chronic disease. The high correlations between separately developed instruments provides convergent validation for the existence of relatively discrete components of health status. The three dimensions of pain, physical disability, and psychological status were found to be quite distinct supporting the postulate of major dimensions of health outcome.[15] The three dimensions identified together explain most of the variance in this factor model.

Aggregate measures made possible by identification of dimensions offer several advantages: health outcomes may be described using fewer scores; score reliability is increased; problems with missing data on individual items are minimized, and greater precision is theoretically achieved.[16]

The AIMS questionnaire identifies psychological disability as an important health status component. While the psychological dimensions did not make a significant contribution to explaining the variability in global health estimates, a separate AIMS data base (n = 317) yielded a significant psychological contribution ($p < .01$) in a similar analysis.[17] The analyses shown here confirm that pain in rheumatoid arthritis can be estimated using relatively simple instruments.[18] While this may represent oversimplification of a complex phenomenon,[19] it appears that clinically relevant measurements can nevertheless be obtained. Items designed to assess pain should not be excluded from patient outcome instruments on the grounds that this dimension is too subjective or too complex.

It is unlikely that these findings are unique to the populations or the specific disease examined in this study.[20] We have used the HAQ instrument successfully (over 21,000 administrations) in patients with osteoarthritis, systemic lupus, and ankylosing spondylitis, and in six different regions of the country.[12] We have used the AIMS instrument successfully in a number of chronic diseases,[21] and others have reported similar findings with their instruments.[8]

TABLE 4—Relationship of Major HAQ/AIMS Scale Groupings to Global Health Status Measures: Results of Regression

Scale Component	Global Health Measures			
	Overall Arthritis Status		General Health Perceptions	
	R^2‡	Standardized Beta‡‡	R^2‡	Standardized Beta‡‡
HAQ	0.49**		0.43**	
Physical		0.45**		0.34*
Pain		0.42**		0.47**
AIMS	0.45**		0.55**	
Physical		0.44**		0.36**
Pain		0.35*		0.51**
Complete HAQ Battery (8 items)	0.64**		0.49**	
Complete AIMS Battery (9 items)	0.56**		0.64**	

‡Proportion of global health measure variance explained by scale components.
‡‡Weight of the scale component in the regression model.
*Significant at the alpha = 0.05 level.
**Significant at the alpha = 0.01 level.

The strong evidence for convergent validity reported here suggests that additional work in measuring health status may proceed with the understanding that carefully developed instruments indeed may assess valid and measurable entities, and that studies of medical care and medical policy may regularly include such measures. These instruments have excellent measurement properties, the convergent validity evidence indicates a definable construct, and the identified dimensions explain the great majority of illness impact as estimated by the patient.

REFERENCES

1. Donabedian A: Evaluating the quality of medical care. Milbank Mem Fund Q 1966; 44:166–206.
2. Williamson JW: Evaluating quality of patient care: a strategy relating outcome and process assessment. JAMA 1971; 218:564–569.
3. Brook RH, Davies-Avery S, Greenfield A, Harris LJ, Delah T, Solomon NE, Ware JE: Assessing the quality of care using outcome methods: an overview of the methods. Med Care 1977; 15(9 Suppl):5–15.
4. McDermott HW: Absence of indicators of the influence of its physicians on a society's health: impact of physician care on society. N Engl J Med 1981; 70:833–843.
5. Rogers DE: Who should give primary care: the continuing debate. N Engl J Med 1981; 205:577–578.
6. Patrick DL, Bush JW, Chen MM: Methods for measuring levels of well-being for a health status index. Health Serv Res 1983; 8:228–245.
7. Brook RH, Ware JE, Davies-Avery A, Stewart AL, Donald CA, Rodgers WH, Williams KN, Johnston SA: Overview of adult health status measures fielded in Rand's Health Insurance Study. Med Care 1979; 17(9 Suppl):1–131.
8. Bergner M, Bobbitt RA, Carter WB, Gilson BS: The sickness impact profile: development and final revision of a health status measure. Med Care 1981; 19:787–805.
9. Steinbrocker O, Traeger CH, Battman RC: Therapeutic criteria in rheumatoid arthritis. JAMA 1949; 140:659–662.
10. Fries JF, Spitz PW, Kraines RG, Holman HR: Measurement of patient outcome in arthritis. Arth Rheum 1980; 23:137–145.
11. Meenan RF, Gertman PM, Mason JH: Measuring health status in arthritis: The Arthritis Impact Measurement Scales. Arth Rheum 1980; 23:146–152.
12. Fries JF, Spitz PW, Young DY: The dimensions of health outcome: The Health Assessment Questionnaire, Disability and Pain Scales. J Rheum 1982; 9:789–793.
13. Meenan RF, Gertman PM, Mason JH, Dunaif R: The Arthritis Impact Measurement Scales: further investigation of a health status instrument. Arth Rheum 1982; 25:1048–1053.
14. Gorsuch RL: Factor Analysis. Philadelphia: W. P. Saunders, 1974.
15. Sackett DL, Chambers LW, MacPherson AS, Goldsmith CH, McAuley RG: The development and application of indices of health: general methods and a summary of results. Am J Public Health 1977; 67:423–428.
16. Stewart AL, Ware JE, Brook RH: Advances in the measurement of functional status: construction of aggregate indexes. Med Care 1981; 19:473–478.
17. Kazis LE, Meenan RF, Anderson J: Pain in the rheumatic diseases: investigation of a key health status component. Clin Research 1982; 31:157A.
18. Huskisson EC: Assessment of clinical trials. Clin Rheum Dis 1976; 2:37–49.
19. Crue BL: Chronic Pain. New York: Spectrum Publications, 1979.
20. Meenan RF, Gertman PM, Mason JH, Dunaif R: The Arthritis Impact Measurement Scales: further investigations of a health status measure. Arth Rheum 1982; 25:1048–1053.
21. Mason JH, Weener J, Gertman PM, Meenan RF: Measuring health status in chronic illness: a comparison of six diseases. Arth Rheum 1981; 24:S101.

ACKNOWLEDGMENTS

Janice Weener, PhD, John McKillip, PhD, Donald Y. Young, PhD, and Byron Brown, PhD, provided most appreciated statistical assistance.

Supported by the Multipurpose Arthritis Center grant numbers AM20610 and AM20613. Training grant number AM07014 from the National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases, and grant number HS03802 from the National Center for Health Services Research.