Low socioeconomic status and patient questionnaires in osteoarthritis: challenges to a "biomedical model" and value of a complementary "biopsychosocial model"

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ABSTRACT

Modern medical care is based largely on a paradigm known as a "biomedical model," in which "objective," high-technology biomarkers guide clinical care, and most health outcomes are determined by health professionals rather than individuals, using drugs as the primary therapy. The biomedical model is spectacularly effective in the acute care inpatient hospital, the setting for 95% of medical education and training, and to guide management of many chronic diseases, such as hypertension and diabetes, for which a "gold standard" biomarker is a major determinant of clinical decisions. This model also has contributed importantly to knowledge of biomarkers, biochemical and structural abnormalities in osteoarthritis (OA) and other rheumatic diseases. However, a biomedical model has many limitations in understanding the long-term course of OA and many chronic diseases in outpatient medicine, the setting of 95% of activities that determine long-term health outcomes. Patient self-report questionnaires provide the most informative data concerning OA patient status and changes in status, and more significant data in the prognosis of outcomes such as mortality than laboratory or radiographic measures. Furthermore, the incidence, prevalence, morbidity, and mortality of OA is considerably greater in individuals of low versus high socioeconomic status. These associations are not unique to OA, and are seen in many diseases, including comorbid conditions which are the acute causes of death in OA. Associations of low socioeconomic and poor health are explained only in small part by limited access to medical services, the conventional explanation. Strong evidence suggests that socioeconomic status is a surrogate marker for patient self-management, actions and environment, in addition to actions of health professionals, in the pathogenesis, course and outcomes of chronic diseases. These observations suggest the value of a complementary "biopsychosocial model" to better understand pathogenesis, principles of treatments, and outcomes in OA and other chronic diseases. Inclusion of clinical information from patient questionnaires and socioeconomic status variables in clinical and research settings could add new understanding of biomarkers and pain in OA for both basic and clinical investigators. Furthermore, the data indicate that poor physical function assessed on a self-report questionnaire might be regarded as an important reversible risk factor in public health and research agendas, for which the OA community might be strong advocates.

Introduction

Modern medical care and research is based largely on a paradigm known as a "biomedical model (1, 2)." In this model, the causes, diagnosis, prognosis, treatment, and outcomes of diseases are determined largely by physical or somatic variables. Mind and body are distinct in the causation and outcomes of diseases, and treatments emphasise pharmacological approaches. General health, the approach to disease, and outcomes are determined primarily, if not exclusively, by actions of health professionals and the medical care system, with relatively little contribution and responsibility on the part of individual patients.

The biomedical model has been spectacularly successful in 20th-century medicine. Perhaps the preeminent example is seen in antibiotic therapy for acute infectious diseases, in which a single "cause" is identified through a

Table I. Prevalence of health conditions in the 18- to 64-year-old population according to level of formal education in 1978.

Health condition	Total number	% of total population	Percentage in four categories by years of formal education				Odds ratios by years of formal education			
			1-8	9-11	12	>12	1-8	9-11	12	>12
Any condition	54,194	42.7%	64.7%	53.5%	41.3%	33.4%	3.6	2.3	1.4	1.0
Arthritis/rheumatism	14,215	11.3%	26.4%	13.1%	11.0%	6.8%	5.0	2.1	1.7	1.0
Symmetric polyarthritis*	2,366	1.9%	8.9%	4.4%	3.1%	1.7%	5.2	2.6	1.8	1.0
Asymmetric oligoarthritis^	4,261	3.4%	14.2%	9.7%	7.0%	4.3%	3.3	2.3	1.6	1.0
Hypertension	14,015	11.1%	26.1%	15.1%	9.5%	7.2%	4.6	2.3	1.4	1.0
Back problems	9,901	7.9%	11.6%	10.5%	7.5%	6.1%	2.0	1.8	1.3	1.0
Nervous/emotional	7,203	5.8%	16.8%	9.4%	5.4%	1.6%	12.3	6.3	3.4	1.0
Stomach ulcer	4,568	3.6%	6.9%	5.7%	3.4%	2.1%	3.4	2.8	1.6	1.0
Diabetes	3,205	2.5%	5.2%	3.6%	2.5%	1.4%	3.9	2.6	1.8	1.0
Kidney trouble	2,354	1.9%	5.1%	2.4%	1.4%	1.3%	4.2	1.9	1.1	1.0
Chronic bronchitis	2,033	1.6%	4.0%	2.3%	1.6%	0.7%	5.6	3.2	2.2	1.0
Heart attack	1,805	1.4%	4.9%	2.0%	1.2%	0.6%	8.8	3.4	2.0	1.0
Cancer	837	0.7%	1.5%	0.6%	0.6%	0.5%	2.7	1.1	1.1	1.0
Stroke	649	0.5%	1.2%	0.8%	0.4%	0.3%	4.1	2.8	1.4	1.0
Multiple sclerosis	148	0.1%	0.0%	0.1%	0.1%	0.2%	0.2	0.4	0.7	1.0

Sources: ref. (10). Most chronic diseases are reported more frequently by individuals with fewer than 12 years of formal education in the age 18-64 United States population, 1987. (27) Substantial work disability and earnings losses in individuals less than age 65 with osteoarthritis: comparisons with rheumatoid arthritis. *Surrogate for rheumatoid arthritis (27). ^Surrogate for osteoarthritis (27).

microbiological culture, leading to rational drug treatment, usually with a "cure" if the host is intact. Similar successes have been seen in pharmacologic treatment of hypertension, hyperlipidaemia, gastroesophageal reflux, and many other diseases, as well as surgical advances in coronary bypass, joint replacement and many others.

A biomedical model provides a primary foundation for understanding pathogenetic mechanisms in disease, through recognition of many biomarkers and biochemical abnormalities, some of which are described in OA in other articles in this supplement. Furthermore, major advances have been made in imaging of OA, also described in this supplement. Research according to a biomedical model will be the primary basis for future advances in prevention and treatment of OA and other diseases.

At the same time, reliance exclusively on a traditional biomedical model may limit optimal patient care, as well as possible advances in basic and clinical research in OA and other rheumatic diseases. Approaches to therapy dominated by medications has limited recognition of the value of exercise as a primary therapy for OA (3, 4). Recognition of similar patient disease burden in OA as comparable to rheumatoid arthritis (RA) has required a patient self-report questionnaire, not a laboratory test or biomarker (5-7). Functional disability appears more significant than imaging or laboratory data in the prognosis of mortality in OA (8), similarly to RA (9). Low formal education level and other markers of low socioeconomic status are associated with a higher incidence, prevalence, morbidity and mortality of OA, and most chronic diseases (10-13).

Other articles in this supplement address the topics of the importance of exercise therapy for OA (14), evidence that the severity of OA is similar to RA in patient groups (15) (recognising that individuals with OA or RA may vary considerably in severity), and mortality in OA (8). Readers who wish to learn more about a biopsychosocial model of disease are encouraged to read those articles. This article will focus on the associations of low socioeconomic status with the severity of OA, the study of which began with an unexpected observation that formal education level was a significant variable in the prognosis of disability and mortality in RA (16-18).

Formal education level and the prevalence OA and most diseases

Low formal education level is associated with a considerably higher prevalence of most chronic diseases. An example can be seen in a population-based 1978 age 18–65 United States Health Interview Survey, incorporated into the Social Security Survey of Disability and Work, and reported in 1989 (10) (Table I). The two most common conditions, arthritis and hypertension, were seen in about 25% of people with fewer than eight years of education (about 10% of the 1978 age 18–65 United States population), 13–15% of people with 9–11 years of education (about 15% of the 1978 United States population), 9–11% of people with 12 years of education (about 38% of the 1978 United States population), and 6–7% of people with more than 12 years of formal education (about 37% of the 1978 United States population) (Table I) (10).

Similar ratios of inverse variation in prevalence of many other diseases according to formal education level was seen for back pain, heart attack, peptic ulcer, diabetes, chronic bronchitis, renal disease, epilepsy, stroke, and tuberculosis (Table I). Only one disease included in the survey, multiple sclerosis, was seen more commonly in individuals with more than 12 years of formal education (Table I) (10). This trend has been found in other studies (19), and multiple sclerosis serves as a "control" for the many diseases in which education is inversely associated with the prevalence of a disease that the observed trends indicating associations

Table II. Prevalence of radiographic knee OA, knee symptoms and self-reported arthritis according to educational attainment, total, and by sex.

Years of education	Both sexes Prevalence (%)	Men only Prevalence (%)	Women only Prevalence (%)
	Radiographic knee osteoarthritis		
0-8	163/1747 (9.3)	59/905 (6.5)	104/842 (12.4)
9-11	52/1137 (4.6)	16/466 (3.4)	36/671 (5.4)
12	64/2260 (2.6)	18/925 (2.0)	46/1335 (3.5)
13+	40/1560 (2.6)	12/803 (1.5)	28/757 (3.7)
Totals	319/6704 (4.8)	105/3099 (3.4)	214/3605 (5.9)
	Symptomatic knee pain		
0-8	381/1776 (21.5)	173/918 (18.9)	208/858 (24.2)
9-11	168/1162 (14.5)	53/47 (11.3)	115/692 (16.6)
12	265/2322 (11.4)	107/940 (11.4)	158/798 (11.4)
13+	190/1620 (11.7)	90/822 (11.0)	100/798 (12.5)
Totals	1004/6880 (14.6)	423/3150 (13.4)	581/3730 (15.6)
	Self-report arthritis at any site		
0-8	682/1776 (38.4)	288/918 (31.4)	394/858 (45.9)
9-11	313/1162 (26.9)	104/470 (22.1)	209/692 (30.2)
12	479/2322 (20.6)	151/940 (16.1)	328/1382 (23.7)
13+	288/1620 (17.8)	108/822 (13.1)	180/798 (22.6)
Totals	1762/6880 (25.6)	651/3150 (20.7)	1039/3730 (27.9)

Source: ref. (21). Educational attainment and osteoarthritis: differential associations with radiographic changes and symptom reporting.

of low education with high prevalence of most diseases were not an artefact of the computer database. A few diseases, including allergies and thyroid disease, did not vary significantly according to years of formal education (10).

Most health professionals, politicians and the general public attempt to "explain" associations between formal education level and poor health on the basis of limited access to medical care for disadvantaged people of low socioeconomic status (20). This "explanation" reflects a biomedical model perspective that health professionals are the primary determinants of good health outcomes, reinforced daily in acute-care situations in hospitalised patients. However, trends toward substantially poorer status of people of low education level or other indicator of socioeconomic status are seen in many countries with universal access to care [see (11)], and in many reports from medical care settings concerning patients who obviously had at least some access to care, although differences in long-term access may exist.

It has been suggested that patient self-management, in contrast to professional medical intervention, may be a primary basis for associations between education and health (11). Socioeconomic status may be a surrogate for many actions of patients, which may be as important in health outcomes as actions of health professionals. Similarities of odds ratios of many different diseases may suggest some common pathophysiologic variable proximate to recognised pathophysiological mechanisms in many diseases, possibly at the level of the central nervous system, as psychological problems are associated with the highest odds ratios according to education level (Table I).

Another population-based study, the first National Health and Nutrition Examination Survey of 1971-75 (NHANESI), is instructive concerning associations of educational level with OA (21). A 2–3-fold higher prevalence of OA is seen in individuals with fewer than 8 years of education compared to more than 13 years, generally with a gradient for 4 education groups of <8, 9–11, 12 and >12 years (21) (Table II), similar to data from the Health Interview Survey in Table I. Similar ratios were seen according to each of 3 criteria for OA of the knee: radiographic knee OA – seen in 4.8% of the total population; symptomatic knee pain – seen in 14.6% of the population; and self-report of arthritis at any site – seen in 25.6% of the population (Table II).

Gradients in OA severity according to education level are similar for radiographs [and laboratory tests in RA (22)] to those seen according to self-report questionnaire responses (Table II). [Discordance according to the 3 criteria for knee OA is discussed in detail elsewhere (23)]. When adjusted for age, race, sex and smoking, ratios of OA severity according to education level were somewhat attenuated, but remained significant in the lowest education group (<8 years) (Table II) (21). Even adjustment for body mass index and knee injury reduced the odds ratios to non-significant levels only for radiographic OA in individuals with the lowest levels of formal education (Table II) (21).

Associations of education level with clinical status of patients with OA seen in routine care

A comparison in a clinical setting indicated significantly poorer scores for both physical function and pain in 82 OA patients with 11 or fewer years of education *versus* 124 patients who had 12 or more years of education (Table III) (24). Patterns were similar in RA, with somewhat higher pain scores in OA compared to RA and somewhat higher physical function scores in RA compared to OA (24), an observation which is discussed in detail in another article in the supplement (15).

Furthermore, differences in both physical function and pain scores according to education level were greater than according to age or duration of disease (Table IV) (24). The only statistically significant differences in the beta coefficients of regressions to characterise differences in physical function were seen for education level in both OA and RA; differences in pain scores were significant only in OA (Table IV) (24). No differences in either physical function or pain scores according to age or duration of disease were statistically significant (Table IV) (24).

In general, various measures of socioeconomic status, including formal

Table III. Responses of patients with osteoarthritis or rheumatoid arthritis for physical function and pain scores analysed according to formal education level.

	Years of formal education	Number of patients	Physical function (0-3)	*p*-value	Pain visual analogue scale (0-10)	*p*-value
Osteoarthritis	≤11 yr	82	0.7	0.0002**	7.0	0.001
	>12 yr	124	0.5		5.5	
Rheumatoid arthritis	≤11 yr	50	1.1	0.005*	5.7	0.12
	>12 yr	83	0.8		4.9	

Source: ref. (24). Self-report questionnaires in five rheumatic diseases: Comparisons of health status constructs and associations with formal education level.
*$p \leq 0.05$ adjusted for multiple comparisons using Bonferroni adjustment.
**$p \leq 0.01$ adjusted for multiple comparisons using Bonferroni adjustment.

Table IV. Regression analyses of responses of patients with osteoarthritis or rheumatoid arthritis on scales for physical function and pain analysed according to age, disease duration, and formal education level.

	Physical function						Visual Analogue Pain Scale					
	Years of formal education		Duration of disease		Age		Years of formal education		Duration of disease		Age	
	Beta	*p*-value	Beta	*p*-value	Beta	*p*-value	Beta	*p*-value	Beta	*p*-value	Beta	*p*-value
Osteoarthritis	-0.16	0.02	-0.02	0.79	-0.01	0.94	-0.22	<0.01	-0.01	0.90	-0.02	0.79
Rheumatoid arthritis	-0.17	0.05	-0.06	0.54	0.10	0.30	-0.05	0.54	-0.11	0.24	-0.17	0.07

Source: ref. (24). Self-report questionnaires in five rheumatic diseases: Comparisons of health status constructs and associations with formal education level.

Table V. Associations between socioeconomic status variables and WOMAC function, pain, stiffness and total scores among participants with radiographic knee OA (n=782).

	WOMAC Function β (95% CI)	WOMAC Pain β (95% CI)	WOMAC Stiffness β (95% CI)	WOMAC Total β (95% CI)
Individual SES models				
<12 years education€	3.57 (1.25,5.90)**	0.67 (-0.02,1.37)	0.31 (0.00,0.62)	4.56 (1.41,7.70)**
Non-managerial occupation£	2.91 (0.68,5.14)*	0.93 (0.26,1.59)**	0.21 (0.09,0.51)	4.05 (1.04,7.05)**
Poverty rate 12–25%¬	1.76 (0.704.23	0.32 (0.42,1.05)	0.13 (0.20,0.46)	2.21 (1.10,5.54)
Poverty rate >25%¬	3.18 (0.03,639)*	0.87 (0.09,1.83)	0.22 (0.21,0.65)	4.27 (0.06,8.60)
Mutually adjusted SES models∞				
<12yrs education€	2.83 (0.38,5.28)*	0.39 (0.34,1.12)	0.26 (0.07,0.59)	3.48 (0.18,6.78)*
Non-managerial occupation£	1.96 (0.39,4.30)	0.78 (0.08,1.48)*	0.12 (0.19,0.44)	2.86 (0.30,6.02)
Poverty rate 12–25%¬	1.68 (0.77,4.13)	0.30 (0.44,1.03)	0.12 (0.21,0.45)	2.11 (1.20,5.42)
Poverty rate >25%¬	2.81 (0.38,6.01)	0.77 (0.19,1.73)	0.19 (0.24,0.63)	3.78 (0.54,8.09)

All analyses are adjusted for age, gender, body mass index, hip pain, number of comorbidities and occupational and physical activity score.
WOMAC: Western Ontario McMaster Universities osteoarthritis index.
€Referent: 12 or more years of education equal 12 years or more education. £Referent: managerial occupation. ¬Referent: poverty rate <12%. *$p<0.05$, **$p<0.01$.
∞All socioeconomic status measures included in the same model. Source: ref. (13).

education, occupation, or income have been found to be associated with higher prevalence and higher severity of many diseases, as well as increased mortality rates associated with these diseases, at higher levels than age or duration of disease prior to age 65. Nonetheless almost every report of clinical trials or other clinical research, or patient notes in a medical record, include age and duration of disease, but fewer than 20% include a measure of patient socioeconomic status.

An interesting analysis was performed in studies of associations of socioeconomic variables with disability and pain in participants in the North Carolina Johnson County Osteoarthritis Project with radiographic knee OA (13). In addition to education and occupation, the investigators also analysed community poverty rate, defined as the proportion of individuals in a given block group in which 25% of residents were below the poverty line, as a potential explanatory variable for more severe OA.

In a series of univariable regressions in participants with radiographic knee OA, the socioeconomic variables education level <12 years *versus* 12 or more years and non-managerial versus managerial occupation were associated with poor WOMAC function, but only non-managerial occupation was associated with higher WOMAC pain (12). The magnitude of community poverty >25% as explanatory of poor WOMAC function was in the same range as formal education <12 years (Table V) (13).

Similar observations were made for OA of the hip, in which low formal education and community poverty, but not non-managerial status, were associated significantly with severity (12). These findings add a further explanatory variable, community poverty, to recognised associations between low socioeconomic status and OA severity.

Discussion

This brief review summarises only a few of hundreds, if not thousands, of published reports concerning low socioeconomic status as a major risk factor for developing OA and many other diseases prior to age 65, as well as more severe clinical status after disease onset and higher mortality rates in general and associated with many specific diseases. The primary purpose of the article is to raise awareness of associations of low socioeconomic status with poor health to the attention of readers, whether clinicians, basic or clinical researchers, as many health professionals (and the general public) appear unaware of these associations. Socioeconomic status variables usually are as significant or more significant than age or duration of disease to explain differences in status of patients with several diseases, including OA (24).

Associations of low socioeconomic status and poor health often are "explained" in the medical literature as due to limited access to medical services. Limited access certainly is critical in acute medical situations, in which timely availability of access may determine survival or death. The importance of acute medical services is reinforced by the conduct of about 95% of medical education and training in acute care hospitals, in which doctors give "orders" and outcomes depend almost entirely on actions of health professionals.

At the same time, 95% of activities that result in lifetime differences in health status occur outside of acute care settings. Contact with health professionals generally occurs only a few hours a month at most. Outcomes depend in large part on actions of the individual, although health can be affected substantially by effective treatments and education from health professionals. Nonetheless, health professionals have far less control and many more limitations to affect outcomes in outpatient settings than in acute care hospitals. Furthermore, a patient has many more opportunities compared to a health professional to make favorable or unfavorable decisions that affect the patient's health. Although a component of associations of low socioeconomic status with poor health status may result from limited access to medical services, much of the data concerning these associations have emerged from medical settings, at which there was obviously access to services on at least one occasion.

Associations of education and health do not appear to meet criteria of a "biomedical model," the dominant paradigm of modern medicine, that causation and severity of disease are explained entirely by biochemical and immunologic mechanisms, that are recognised (as in RA) or waiting to be recognised (as in OA) as biomarkers. Of course, biomarkers and other high-technology information that emerge from basic and clinical biomedical research will ultimately explain pathogenesis and are required for the development of new treatments. Nonetheless, it is possible that inclusion of clinical data concerning pain, physical function, other self-report severity variables, as well as socioeconomic status variables, which can cumulatively be described as components of a complementary "biopsychosocial model" of disease, could add important understanding to data concerning biomarkers, imaging findings and other new information concerning OA and other diseases.

Many important discoveries in rheumatology, such as the LE Cell (25) and rheumatoid factor (26), which established the immunologic basis of inflammatory rheumatic diseases, emerged from serendipitous observations, rather than from structured hypothesis-driven research studies. These discoveries were possible to extend a biomedical model of disease in the setting of a laboratory infrastructure which facilitated opportunities to make the observations. Similarly, many observations over recent years in rheumatology, such as premature mortality in rheumatic diseases and the importance of socioeconomic status as a risk factor for poor health explained only in small part by limited access to medical services, emerged from serendipitous observations. These observations were possible through availability of an infrastructure of longitudinal databases of patient-reported data, to extend a complementary biopsychosocial model of disease. However, at this time, while laboratory infrastructures are ubiquitous in medical care settings, databases of patient-reported data remained unusual, despite relatively low costs to yield important data.

We suggest that all clinical encounters and research activities include a patient questionnaire measure of function, pain, and other relevant variables, as well as a marker of socioeconomic status. The most easily collected variable to assess socioeconomic status remains years of formal education, a robust marker pertaining to health, generally (but not always) as significant as any other marker of socioeconomic status. We also suggest maintaining a simple longitudinal database of patient-reported data in clinical and research settings, as the significance of available information, whether biomarker, genetic, imaging, or patient questionnaire data, often is not apparent in cross-sectional studies, but may become clear over time in many chronic diseases such as OA, often through serendipitous observations.

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