Household Income and Earnings Losses Among 6,396 Persons with Rheumatoid Arthritis

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ABSTRACT. ***Objective.*** Rheumatoid arthritis (RA) causes disability and reduced productivity. There are no large quantitative studies of earnings and productivity losses in patients with clinical RA, and no studies of household income losses. We describe methods for obtaining earnings and household income losses that are applicable to working as well as nonworking RA patients, and we perform such studies using these methods.

Methods. We estimated cross-sectional expected annual earnings and household income losses in 6,649 persons with RA from Current Populations Survey (CPS) and O*NET (Occupational Information Network) data, and we estimated expected household income and earnings losses based on demographic characteristics after adjustment to Medical Outcomes Study Short-Form 36 (SF-36) population norms (internal method). Workplace productivity was measured by the Work Limitations Questionnaire (WLQ).

Results. 27.9% of patients aged ≤ 65 years considered themselves disabled after 14.6 years of RA, and 8.8% received disability benefits. Annual earnings losses ranged between $2,319 and $3,407 by the CPS and internal method (preferred), with losses of 9.3% and 10.9%. A 0.25 difference in Health Assessment Questionnaire (HAQ) score was associated with a $1,095 difference in annual earnings. Productivity losses were 6% based on work limitations identified by the WLQ. Household income loss (percentage loss) including transfer payments was $6,287 (11.8%) for all patients, $4,247 (6.9%) for employed patients, and $7,374 (14.8%) for nonworking patients. Among nonworking nondisabled patients aged ≤ 65 years, income loss was 14.1%.

Conclusion. As measured by annual household income loss, the overall impact of RA is $6,287 (11.8%). Earnings and household income are dependent on functional status, education, age, ethnicity, and marital status. Income loss is predicted by the HAQ, HAQ-II, Modified HAQ, and SF-36. (J Rheumatol 2005;32:1875–83)

Key Indexing Terms:
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Earnings and income losses are important from differing perspectives. From the patients' perspective, they are a measure of illness burden and opportunities lost because of rheumatoid arthritis (RA). In this context, however, household income loss may be most important, as it reflects the contribution of transfer payments and the activities of other members of the household that may additionally increase or decrease household income. It represents, in effect, the total monetary impact of RA on the household [see Appendix for a glossary of economic terms].

The societal perspective is different and is focused on lost productivity. The most common way to value productivity is to translate it into economic terms, usually using the "human capital approach" (HCA)[1]. In the HCA, productivity losses represent the economic equivalent of decreased or lost productivity. The HCA estimates productivity as a function of wages in which an hour lost is the equivalent of an hour's wages. The HCA also considers presenteeism, or decreased productivity while employed[2]. From the societal perspective, only decreased productivity and disability (no productivity) are usually considered. Payments to those who are disabled (transfer payments) are not part of the burden of RA from the societal approach. From the perspective of the employer, only decreased productivity is usually considered, as persons who become work disabled are replaced by other workers.

Although the common metric of all the differing per-

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spectives is money, there are a number of problems with the human capital approach from the patient perspective. For one thing, this assignment of value does not usually value the work of those who have chosen not to be employed (although rare studies have put a valuation on such work) or the effect of possible increased or decreased productivity by household members in response to the patient's illness. An indirect and partial approach to measuring such productivity losses is to determine household income loss in the absence of transfer payments when RA patients are not working and not disabled.

Many healthcare analysts believe that the value of lost productivity due to morbidity in cost-effectiveness analyses can be better valued by the Quality Adjusted Life-Years (QALY) approach[3], which considers productivity losses as being captured within quality of life assessments. However, the QALY approach is not generally applicable to non-cost-effectiveness studies, and does not allow disaggregation of indirect costs.

One important limitation to the approaches described above as they apply to RA is that they do not account for the effect of illness severity, an effect that is usually measured by functional assessment. If one were able to determine the relationship between functional status and employment and household income loss, then it might be possible to estimate the actual or preventive effect of treatment interventions.

While it is easy enough to outline the dimensions of earnings and income loss studies, it is not easy to carry them out. The consequence of the difficulty in acquiring and measuring earnings and household income loss is that there are no studies that fully address these areas among clinically related RA cost studies[4-16]. In this cross-sectional study, we have 4 aims: (1) to determine the earnings and income loss in patients with RA, including household income loss among those who are not working; (2) to describe and validate a method of estimating earnings and income loss based on reduction in health status; (3) to determine productivity loss using the Work Limitations Questionnaire (WLQ) and to evaluate the comparative usefulness of the questionnaire; and (4) to determine the earnings and household income loss associated with changes in functional status as measured by commonly used rheumatology assessments, such as the Health Assessment Questionnaire (HAQ) and Medical Outcomes Study Short-Form 36 (SF-36)[17-19].

MATERIALS AND METHODS

Patient sample. Patients in this study were participants in the National Data Bank for Rheumatic Diseases (NDB) longitudinal study of RA outcomes. Patients are recruited from the practices of United States rheumatologists[20–22], and are followed thereafter with semiannual questionnaires sent by the NDB. This followup is unrelated to any clinic visits that may occur. The NDB represents an open cohort in which patients are added continuously. About 8% of patients decline to participate per year. This report concerns the status of 6,396 patients with RA who completed at least one detailed semiannual survey questionnaire covering one 6-month period during the 18-month period from July 2001 through December 2002. In the event more than one questionnaire was completed, the most recent questionnaire was chosen for analysis. The mean reporting year was 2002 for 41.7% and 2001 for 58.3%. Questionnaires are mailed in January and June and refer to the previous 6-month period. The NDB also recruits patients for safety registries that are sponsored by pharmaceutical companies. As patients in these registries may not be typical of RA patients in general, they were excluded from analysis in this study. Patients in the NDB have higher education levels and are less likely to be members of minority groups compared with the general populations[23] (see Results for specific details). Patients were divided into groups according to employment status, regardless of age: a group of 1,691 persons who were employed and 4,705 who were not employed.

Demographic and disease status variables. NDB participants were asked to complete semiannual, detailed 28-page questionnaires about all aspects of their illness. At each assessment, demographic variables were recorded including sex, age, ethnic origin, education level, current marital status, and medical history. Functional assessment measures included the Stanford Health Assessment Questionnaire functional disability index (HAQ disability)[17], the modified HAQ (MHAQ)[24], the HAQ-II, a shortened, modified version of the HAQ with similar scaling but superior psychometric properties[25], and the SF-36, from which the physical component summary score (PCS) and the mental component summary score (MCS) were calculated[18,19]. The PCS and MCS summary scores are both based on weighted contributions of the eight SF-36 subscales: physical function, physical role, total pain, general health, vitality, social function, emotional health, and mental health. The PCS is more strongly weighted by physical function subscales and the MCS by mental, vitality, and social subscales. The weights are such that in a general US population the mean PCS and MCS score will be 50 and the standard deviation will be 10. Household income was assessed with a multiple choice question, "Which income group comes closest to your total household income in the last year from all sources before taxes?" Eleven choices were available, ranging from "Under $10,000" to "$100,000 or more."

Work related variables. Patients report annual total household income from all sources. Patients who were employed report annual earnings and the number of hours worked. The ability to perform specific work tasks was assessed with the WLQ[26,27], a 25-item, self-administered questionnaire designed for assessing groups of individuals ("respondents") who are currently employed[28]. The WLQ indicates the degree to which health problems interfere with specific aspects of job performance (called "on-the-job disability" or "presenteeism") and the productivity effect of these work limitations. The WLQ index is calculated from 4 subscales and is weighted based on analysis of the relationship between WLQ scale scores and actual employee productivity[28]. Scores may be interpreted as the percentage loss in productivity compared to a healthy (not limited) employee or the percentage increase in work hours required to compensate for productivity loss, after consulting with a conversion table[28]. The WLQ has been shown to be reliable and valid[26,27]. The WLQ was administered to all persons who were employed for any time during the previous 6 months.

Expected earnings [Current Population Survey (CPS)]. Expected earnings are determined using inflation-adjusted data from US Bureau of Labor Statistics data from the CPS for all workers (fulltime and part-time) during 2001[29]. CPS data in this survey are categorized by age, sex, ethnicity, and educational attainment. CPS educational attainment data are comprehensive and match fully with NDB educational attainment data. Roughly 60,000 households are surveyed. The data have a nonresponse rate of 16.2% and undercoverage of roughly 8%. Technical details regarding reliability are available[30].

Adjustment for nonparticipation bias. Because study participants may be systematically different from nonparticipants, we compared PCS and MCS scores for employed persons in this study with persons who had previously dropped out of the NDB studies. By regression analyses, we estimated the age, sex, ethnicity, and education-adjusted PCS and MCS scores for participants and nonparticipants and then used those values of PCS and

MCS to compute the difference between expected CPS earnings and actual earnings. The difference in annual earnings estimation between participants and nonparticipants suggested that earnings of study participants would have been $375 less had there been no nonparticipation.

*Expected earnings (O*NET classification)*. Expected earnings using the Occupational Information Network (O*NET) classification system were based on identifying individual current RA patient occupations and earnings (2001) for fulltime workers for those occupations specified by O*NET[31,32] (US Department of Labor, Employment and Training Administration). Earnings were adjusted for hours worked and to the year 2002. O*NET is a comprehensive database of worker attributes and job characteristics. It is intended as the replacement for the Dictionary of Occupational Titles (DOT)[33]. Occupational income data have a relative standard error of 0.2%[34]. To make the data compatible with all workers, rather than fulltime workers only, we reduced expected O*NET earnings (expected × 0.849) based on the differential between fulltime workers and all workers provided by the CPS.

Expected earnings and expected household income (internal method). Using population-based expected ("normal") values for PCS and MCS in 14 age- and sex-specific categories[35], we used regression analysis to estimate earnings for patients in those categories had their PCS and MCS values been at the norm. Earnings losses represented the difference between the SF-36-adjusted predicted earnings and the actual earnings. Household income was similarly modeled in working and nonworking RA patients. We chose to use SF-36 data because of the availability of population norms and because the HAQ family of questionnaires has unacceptable floor effects[36].

To determine poverty levels, we used the US Health and Human Services (HHS) poverty guidelines for the 48 contiguous states for the years 1998–2003[37]. Poverty guidelines are simplified versions of the federal poverty thresholds, and are based on income level in a given year and the number of persons in a household. A level of 185% of the HHS poverty guideline, selected for this study, is a commonly used measure of poverty, and is used to determine eligibility for the School Breakfast and Lunch programs. The level of educational attainment data in the general population was obtained from the US Census report of 2002[38].

Statistical methods. For the internal method listed above, we modeled the relationship between earnings and age and between household income and age by regression analysis. Because some of the relationships were nonlinear and some of the data were censored, we used special methods of analysis. Technical details follow for those interested in the specifics: because the relationships between earnings and age and between household income and age were not linear, age was modeled using linear splines with cutpoints at 40 and 65 years of age. As household income and earnings are captured in categories that are censored at $5,000 and $100,000, censored interval regression was used to model the relationship between these variables and predictor variables. For confirmation, we performed median regression analyses, with and without fractional polynomial predictors. Results were very similar to those obtained with censored interval regression, and the censored interval regression results are presented. The specific model used in these analyses included the following dependent variables: PCS, MCS, sex, age as splines (age1 age2 age3), educational attainment, ethnicity, and marital status. Although the population norms of the PCS and MCS are 50 in the whole population, they change according to age and sex. To adjust to SF-36 norms in this study we created 14 age/sex groups and adjusted PCS and MCS scores to norms for each of these groups.

For key study variables, missing data occurred at rates of 1.5% for HAQ, 7.0% for PCS and MCS, and 12.2% for household income. There were no specific patterns of missingness and data were missing at random. To replace missing data, multiple imputations and a predictive model-based method and 5 data sets were used[39-41]. Predictors included age, sex, HAQ, pain on a visual analog scale (VAS), VAS global severity, education, and marital status.

The data of this study are cross-sectional. When we speak of prediction, we use the term in the statistical sense for cross-sectional data and not to refer to future observations. Statistical computations were performed using Stata[42].

RESULTS

Demographic and severity characteristics. The mean age of the 1,691 employed RA patients in this study was 55.3 (SD 11.5) years (Table 1), of whom 19.4% were > 65 years old, 10.4% > 70 years old, and 1.7% > 80 years old. Seventy-four percent of the employed patients were women. A college degree or greater education level was attained by 38.5%. The college degree rate was 9.7% greater than expected compared with a US population rate adjusted to the ethnic characteristics of the RA study patients. Non-Hispanic whites comprised 92% of the employed study population compared with 83% of persons 18 years and older in the US population in 2002 (US Census data). The consequences of RA were seen in the mean HAQ scores of 0.8 and the SF-36 physical component score of 35.8.

As expected, nonemployed persons (Table 1) were older [64.4 (SD 12.5) yrs], had longer duration of RA (14.6 yrs), and had more abnormal HAQ and PCS scores. Median household income was $20,000 lower than in employed patients, and 23.9% were at or below 180% of the poverty level compared with 12.0% of those who were employed. Medicare disability and Medicaid (public assistance) were received by 0.8% and 1.4% of working patients and 8.8% and 6.1% of nonworking patients, respectively.

Earnings and earnings losses. As shown in Table 2, the median earnings of the 1,691 RA patients were $25,000

Table 1. Characteristics of 1,691 employed and 4,705 nonemployed RA patients.

Variable	Mean or % (SD)	Mean or % (SD)
Employment status	Employed (N = 1,691)	Not employed (N = 4,705)
Age, yrs (%)	55.3 (11.5)	64.4 (12.5)
Sex, % male	25.5	21.7
Education category, yrs, %		
0–8	1.1	2.6
8–11	4.0	8.6
12	30.4	39.5
13–15	27.5	24.3
≥ 16	37.0	25.0
Non-Hispanic white, %	92.7	93.1
Married, %	74.5	70.6
Disease duration, yrs	11.7*	14.6*
HAQ (0–3)	0.8 (0.6)	1.1 (0.7)
MHAQ (0–3)	0.4 (0.4)	0.5 (0.5)
HAQ-II (0–3)	0.8 (0.6)	1.1 (0.7)
SF-36 physical component score	35.8 (9.7)	31.4 (10.7)
SF-36 mental component score	44.7 (13.5)	44.0 (14.4)
WLQ work limitations score	5.6 (5.5)	
Household income, $US	55,000*	35,000*
Annual earnings, $US	25,000*	
Poverty level (185%)	12.0	23.9
Received Social Security disability	0.8**	8.8**
Disabled	4.9**	27.9**

* Median. ** Age ≤ 65 years. Group differences were significant at p ≤ 0.05 for all variables.

Table 2. 2002 median earnings, expected earnings, and earnings losses ($US) among 1,691 employed persons with RA.

Method	Expected Earnings (95% CI)	Reported Earnings (95% CI)	Earnings Loss (95% CI)
BLS/CPS	26,994 (26,751–27,137)	25,000 (25,000–25,000)	2,319 (1,899–4,240)
O*NET	26,614 (25,632–27,597)	25,000 (25,000–25,000)	1,666 (344–2,989)
Internal	31,360 (30,138–32,583)	27,581 (26,682–28,480)	3,407 (3,209–3,604)

BLS/CPS: Expected earnings from US Bureau of Labor Statistics current population survey (CPS) matched to age, sex, ethnicity, and education attainment of the employed RA patients. Earnings loss adjusted for nonparticipation bias. O*NET: Expected earnings from the Occupational Information Network (O*NET) classification, adjusted to all workers, not just fulltime workers. Internal: Modeled expected earnings based on adjustment of SF-36 PCS and MCS scores to population norms.

(95% CI 25,000 to 25,000). Based on categories of age, sex, ethnicity, and education attainment from the CPS, expected RA earnings were $26,993 (95% CI 26,751 to 27,137). Earnings losses by this method, adjusted for nonparticipation bias, were $2,319 (95% CI 1,899 to 4,240). The CPS reports data on all workers, including fulltime and part-time workers.

The O*NET provides a different approach to expected earnings. In this method, we use the annual earnings associated with each job title for all workers to calculate expected earnings. As shown in Table 2, earnings results were quite similar, with expected median earnings of $26,614 (95% CI 25,632 to 27,597) and earnings losses of $1,666 (95% CI 344 to 2,989).

The third (internal) method shown in Table 2 is based on the expected earnings of the employed RA patients in this study, adjusting their expected earnings to age and sex based norms of the SF-36 PCS and MCS. The modeled reported earnings were $27,581 (95% CI 26,682 to 28,480), the expected earnings were $31,360 (95% CI 30,138 to 32,583), and the earnings loss was $3,407 (95% CI 3,209 to 3,604).

Predicting earnings losses as a function of functional status. As earnings are related to health status, we studied the ability of functional status questionnaires to predict annual earnings. The HAQ, MHAQ, and HAQ-II are short functional status questionnaires. The PCS is a larger and broader physical assessment questionnaire. In addition, we studied the WLQ, an instrument designed to assess the difficulty employed persons have doing their jobs. Although the WLQ assesses function, it does it in a more limited domain of the patient's own employment activities. As expected, all questionnaire results were less abnormal in employed RA patients than were seen in the nonworking group. For example, for working versus nonworking persons, scores were PCS 35.8 versus 31.4, HAQ 0.8 versus 1.1, HAQ-II 0.8 versus 1.1, and MHAQ 0.4 versus 0.5 (Table 1).

All functional status questionnaires predicted earnings (Table 3, Figure 1) except for the WLQ, which was not significantly associated with earnings ($p = 0.056$). The fourth versus first quartile difference, which is a measure of the ability of the scale to capture the range of differences, and the standardized coefficients suggest that the HAQ-II, MHAQ, and PCS perform slightly better than the other scales. Wider first versus fourth quartile difference and greater standardized changes score indicate better ability to detect the effect of function on earnings, and in that respect the HAQ-II is slightly better than the MHAQ, PCS, and HAQ. Differences between the HAQ-II, MHAQ, HAQ, and PCS, however, are not statistically significant.

Regardless of which functional variable is used, it is possible to estimate its association with earnings. A 0.25-unit change in the HAQ is commonly considered to be close to the minimally clinically significant difference[43], and is a difference achieved in all recent clinical trials of disease modifying antirheumatic drugs and biologics. The data shown in Table 3 indicate that a 0.25-unit difference in the HAQ is associated with a $1,095 ($4,372/4) difference in annual earnings. For the HAQ-II a difference of 0.25 unit is associated with a $1,452 change in earnings ($5809/4).

Measuring productivity and earnings in RA patients with a work-specific functional assessment questionnaire: the Work Limitations Questionnaire. The WLQ score can be translated into a percentage decrease in productivity compared to healthy persons. Among the 1,691 employed participants of this study who completed the WLQ, the WLQ index was 5.8 (SD 5.6), which corresponds to roughly a 6% reduction in productivity or the need for an employer to increase hours by about 6% to compensate for productivity loss. When the RA patient sample was restricted to those 1,363 persons < 65 years of age who worked at least 35 hours the WLQ index was also 5.8 (SD 5.6).

The WLQ was significantly correlated with the 4 functional scales used in this study: HAQ ($r = 0.57$), HAQ-II ($r = 0.55$), MHAQ ($r = 0.55$), and PCS ($r = 0.50$). However, the WLQ was almost always less correlated with clinical variables than the HAQ-II, HAQ, MHAQ, and PCS. For example, the correlation between WLQ and VAS pain was

Table 3. Association of functional status and earnings among 1,691 persons with RA.

Scale	Value Among Working Persons with RA, mean (SD)	Wage Change per 1-unit Scale Change, $US (95% CI)*	Wage Change per 1 SD Change in Scale $US*	4th vs 1st Quartile Wage Difference, $US (95% CI)*
HAQ-II	0.8 (0.6)	5,809 (3,195–8,423)	3,270	9,650 (5,615–13,686)
MHAQ	0.4 (0.4)	7,538 (4,045–11,033)	3,100	7,599 (3,770–11,428)
PCS	35.7 (9.7)	323 (176–471)	3,129	7,576 (3,568–11,585)
HAQ	0.8 (0.6)	4,372 (2,078–6,607)	2,790	7,519 (3,498–11,539)
WLQ	5.8 (5.6)	249 (–503–6)	1,390	3,419 (–7,424–585)

* Adjusted for age, sex, education attainment, marital status, and ethnicity. PCS: SF-36 physical component score; HAQ: Health Assessment Questionnaire; HAQ-II: Health Assessment Questionnaire-II; MHAQ: Modified Health Assessment Questionnaire; WLQ: Work Limitations Questionnaire.

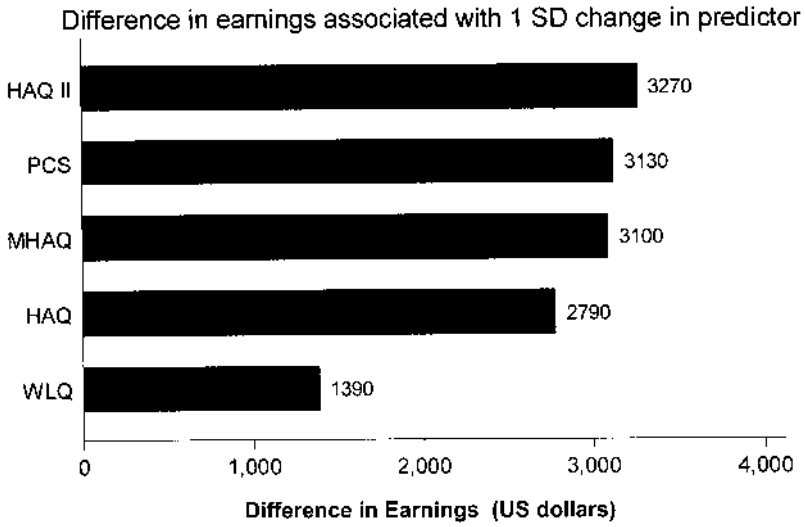

Figure 1. Relationship between a 1 SD change in functional assessment scores and changes in annual earnings. Differences between HAQ-II, PCS, and MHAQ are not significantly different. PCS: SF-36 physical component score; HAQ: Health Assessment Questionnaire; HAQ-II: Health Assessment Questionnaire-II; MHAQ: Modified Health Assessment Questionnaire; WLQ: Work Limitations Questionnaire.

0.465, while the correlations with the HAQ (r = 0.589), HAQ-II (r = 0.609), MHAQ (r = 0.626), and PCS (r = 0.640) were significantly greater ($p < 0.001$). Correlations did not change substantially when the sample was restricted to the 1,363 persons < 65 years of age who were working at least 35 hours per week.

When adjusted for age, sex, marital status, education, and ethnicity, a unit change in the WLQ index was associated with a $249 (95% CI –6 to 503, p = 0.056) reduction in earnings. However, the WLQ was least related to earnings of all the measures in Table 3. In addition, the standardized coefficient and fourth versus first quartile difference was smallest for the WLQ when compared with the other functional measures. These data indicate that the WLQ is the least responsive questionnaire of the functional and work status questionnaires that were studied. The WLQ had a similar lesser relationship with earnings when the sample was restricted to the 941 persons < 65 years of age who worked at least 40 hours per week [$251 (95% CI –42 to 542, p = 0.093)].

Household income and household income loss in RA. The overall reduction of annual household income in 2002 dollars was $6,387 (95% CI 6,210 to 7,444) (Table 4), based on the indirect SF-36 adjustment method. Among all employed persons the annual reduction of household income was $4,247 (95% CI 3,361 to 5,135), but when persons not employed were considered, the annual household income loss increased to $7,374 (95% CI 6,488 to 8,260). To clarify household income loss among persons who were not employed for pay, we analyzed data on those who were not employed and were less than 65 years of age, the conventional age of retirement. Among the nonemployed under age 65 years, we noted a household income reduction of $11,361 (95% CI 10,620 to 12,101). When these analyses were fur-

Table 4. Annual household income loss in patients with RA by age, employment status, and disabled status.

Patient Category	Age Category	No. of Patients	Household Income Loss, $ (95% CI)	Predicted Household Income, $ (95% CI)	Actual Household Income, $ (95% CI)
All	All ages	6,357	6,287 (6,210–7,444)	53,088 (52,207–53,969)	46,261 (45,717–46,803)
Employed	All ages	1,685	4,247 (3,361–5,135)	61,702 (60,592–62,813)	57,454 (56,568–58,340)
Not employed	All ages	4,672	7,374 (6,488–8,260)	49,658 (48,428–50,889)	42,284 (41,635–42,933)
Not employed	< 65 years	2,213	11,361 (10,620–12,101)	61,582 (60,521–62,644)	50,221 (49,252–51,192)
Not employed (not disabled)	< 65 years	1,673	9,051 (8,308–9,795)	64,142 (63,071–65,214)	55,091 (54,028–56,154)
Not employed (disabled)	< 65 years	540	5,643 (2,031–9,255)	40,953 (36,954–44,960)	35,309 (33,590–37,029)

ther restricted to patients who were not receiving disability benefits and did not consider themselves work disabled, household income loss was $9,051 (95% CI 8,308 to 9,795). Finally, among those aged ≤ 65 years who reported themselves as being disabled, household income loss was $5,643 (95% CI 2,031 to 9,255). For all the patient and age categories of Table 4, the predicted household income is based on patients in the category, adjusted to the age and sex population norm of the PCS and MCS.

DISCUSSION

There is general agreement that RA results in reduced earnings. A number of studies have addressed indirect costs and/or productivity costs in RA, with the general agreement that decreased productivity and work disability are significantly increased in this illness[6-15]. However, there have been few quantitative studies of earnings and no studies of household income. Early reports suggested earnings losses were as great as 50% compared with pre-RA income levels[4,5]. Newhall-Perry, *et al* (N = 150) and Albers, *et al* (N = 186) noted decreased income in RA patients and, importantly, noted that it occurs early in the course of RA[6,7]. Job histories were used by Kochevar, *et al* in 1997 to estimate earnings losses of $13,900 to $18,409 based on 26 patients[10]. In the largest and most detailed report, Mitchell, *et al* reported that women and men with symmetrical polyarthritis in the general population had annual earnings losses in 1986 dollars of $2,089 and $3,862, respectively[16]. Accounting for inflation and the sex distribution of RA patients in the current study, the Mitchell estimate increases to $4,155 in 2002 dollars. While this study had great strengths it also had some limitations. The diagnosis of symmetrical polyarthritis, as a surrogate for RA, may have included persons who did not have RA, and the age limits for the study were 18 to 65 years, effectively excluding as many as 40% of RA patients. In addition, the Americans with Disability Act, the increasing entry of women into the workplace, and more effective therapies have changed the canvas upon which the consequences of RA are played out.

We used 3 methods to estimate earnings losses. In the first method we used CPS data that matched RA patients in the study to persons in the general population based on age, sex, ethnicity, and education attainment. These data indicated an income loss of $2,319 after adjustment for nonparticipant bias. Despite correcting for nonparticipation bias and adjusting for age, sex, ethnicity, and education attainment, it seems likely that patients attending rheumatology clinics may differ in unmeasurable ways from persons with RA in the community. Therefore the $2,319 earnings loss should be considered a conservative estimate.

In the second method, we used O*NET data that compared RA patients matched on specific job title, age, sex, and ethnicity. An income loss of $1,666 was noted. The O*NET method accounts for specific jobs, but is limited in that it does not account for earnings differences due to sex, age, or longevity on the job.

The third and preferred method used to estimate earnings (internal method) was based on differences between patients' earnings had their SF-36 score been adjusted to the population norm and patients' earnings with no adjustment for SF-36 PCS and MCS scores. These data show earnings losses of $3,407. As this method does not rely on external data and problems with patient/CPS matching, we think it is likely that earnings losses by this method — or preferred method — are the most accurate. Even so, patients may have differed in other non-observed ways, perhaps leading to a slight overestimation of earnings losses. It should also be noted (Table 2) that the modeled reported earnings are greater than the unmodeled median earnings ($27,581 vs $25,000). This occurs because of the 10,000-dollar income intervals that are bounded at $5,000 and $100,000 and are modeled in the censored interval regression.

Taken as a whole, our data show that median earnings losses in RA are between $2,319 and $3,407 by the CPS and internal method, with losses of 9.3% and 10.9%. A 0.25-unit

difference in HAQ score was associated with a $1,095 loss. In addition to earnings losses, 27.9% of patients under age 65 years consider themselves disabled at a median duration of RA of 14.6 years, and 8.8% received social security disability benefits.

In addition to earnings we also considered household income, using the internal SF-36-based methods. The median household income loss (percentage loss) was $6,287 (11.8%) for all patients, $4,247 (6.9%) for employed patients, and $7,374 (14.8%) for patients who were not working. Household income also includes transfer payments (e.g., disability and retirement payments). Among nonworking patients under age 65 years, the percentage loss of income was 18.4%. Among those who are disabled, the percentage loss was 11.3%, reflecting the influence of the sociodemographic characteristics of the disabled on predicted and actual household income. Applying the internal method has many advantages, as it adjusts for presenteeism and absenteeism in workers, and measures productivity losses among those who are not working or disabled. As proposed, it does not fully account for productivity losses in retired persons who develop RA close to or after retirement from the perspective of the patient; however, it may account for their losses if their ability to work in earlier years was reduced, thereby reducing their future transfer payments.

This discussion details the burden of RA from the patients' perspective, but can also be used in some longterm models of cost effectiveness. In addition, Table 3 presents the quantitative association between functional status measures and earnings losses. These data may be useful in estimating the possible improvement in earnings losses associated with clinic improvement. For example, as shown above, a 0.25-unit difference in the HAQ is associated with a $1,095 difference in annual earnings. For the HAQ-II a difference of 0.25 units is associated with a $1,452 change in earnings. However, caution should be exercised in extrapolating causal relationships from these cross-sectional data. It is not known whether improving HAQ scores will result in changes in earnings, as this cross-sectional study cannot address this issue. However, it seems likely that keeping HAQ scores at low levels will increase overall productivity. Yelin, *et al* have recently shown that patients treated with etanercept had higher future rates of employment and hours worked[44]. The methods proposed here provide a means to track changes in clinical status and productivity, although this will require a degree of lag time. Although we used both the PCS and MCS in our internal analyses, there was only minimal gain in statistical fit by the addition of the MCS, and simpler models that exclude the MCS are probably sufficient at a practical level (see Table 3).

Earnings losses can be thought of as a surrogate for productivity losses, as they reflect both reduction in work time and presenteeism. In addition to earnings losses that refer to employed patients with RA, household income losses can address productivity losses for the household when working and nonworking patients are considered. As noted in Table 4, household income losses were $6,287 annually, an 11.8% reduction in predicted household income.

We also examined the WLQ, which is designed to assess ability to perform in the patient's specific employment setting. WLQ results of 5.8 suggest that employed RA patients have a reduced productivity of roughly 6%. By contrast, the methods used to assess earnings losses in the study indicate earnings losses of 9.3% and 10.9%. Percentage productivity losses as measured by the WLQ are not the same thing as percentage reduction in income, although the income loss reflects a valuation of patients' activities. The WLQ does not predict earnings well, compared with all other functional assessments. A likely explanation for this is that many RA patients find jobs that they can do, and perform them well, as evidenced by the WLQ. Although the WLQ was designed for the workplace setting, where it can aid employers and identify workplace limitations, it remains an open question whether it will outperform the usual functional assessment questionnaires in RA with respect to predicting work disability. Longitudinal studies now under way should answer this question.

This study has limitations. Participants in survey research have more education and economic resources than persons in the general population, and they differ systematically from RA patients who are nonparticipants. However, we made adjustments for these differences in our analyses. We also assumed that the direction of causality for income loss flows from functional loss to income loss. However, sociodemographic characteristics may influence reporting of health status, and it is possible that we overestimated the role of functional loss in producing income loss for some study participants. We think, nevertheless, that the data presented here provide a useful measure of the dynamics and extent of income and wage losses suffered by people with RA, and, hence, a realistic measure of the burden of RA.

In summary, 27.9% of patients under the age of 65 years considered themselves disabled at a median duration of RA of 14.6 years, and 8.8% received social security disability benefits. Annual earnings losses ranged between $2,319 and $3,407 by the CPS and internal method (preferred), with losses of 9.3% and 10.9%. A 0.25-unit difference in the HAQ score was associated with a $1,095 difference in annual earnings. Productivity losses were calculated at 6% from WLQ scores. The median household income loss (percentage loss), which includes transfer payments, was $6,287 (11.8%) for all patients, $4,247 (6.9%) for employed patients, and $7,374 (14.8%) for patients who were not working. Among nonworking patients under the age of 65 years, the percentage loss of income was 18.4%. Among those who are disabled, the percentage loss was 11.3%, reflecting the influence of the sociodemographic characteristics of the disabled on predicted and actual household income.

Appendix. Definitions of economic terms used in this study.
Absenteeism: The number of days absent from the workplace.
Annual earnings: Pay or wages of a worker for services performed during a specific 1 year period.
Earnings: Salaries, wages, commissions, bonuses, allowances, fringe and prescribed benefits during a 1 year period. Sometimes fringe benefits are excluded. The wording of the NDB survey was "How much did you yourself earn from all your jobs in the last year...before taxes?"
Earnings loss: The difference between expected earnings and actual earnings reported by the patient.
Expected earnings: Determined by 3 methods: (1) Earnings expected based on O*NET characteristics; (2) earnings expected based on US Bureau of Labor data; (3) earnings expected based on earnings of a healthy person, defined as a person with an age and sex adjusted SF-36 PCS and MCS score of 50.
Disabled: Persons receiving Social Security disability payments or considering themselves disabled.
Employed: A person who is performing any amount of paid work or performing unpaid work for a family owned business.
Expected household income: Household income expected based on income of a healthy person, defined as a person with an age and sex adjusted SF-36 PCS and MCS score of 50.
Household income: The total income before taxes for all persons in the household including cash earnings; interest, dividend, rents, and pensions; transfer payments (such as Social Security and assistance programs); and alimony and child support. The wording of the NDB survey was "...your total household income in the last year...from all sources before taxes?"
Household income loss: The difference between expected household income and actual household income reported by the patient.
Human Capital Approach (HCA): A method for placing a monetary value on lost productivity by calculating the expected or potential earnings lost, as a result of a disease or disorder. Within the HCA, 1 hour of lost productivity has the value of 1 hour of a person's wages. The HCA, however, does not usually account for persons who do not work outside the home, such as homemakers and the elderly. The work of these individuals is usually given a zero dollar valuation. However, some studies do account for persons who do not work outside the home.
Not working: Persons not meeting the definition of working.
Non-disabled: Persons not meeting the disability definition above.
O*NET: Occupational Information Network, a comprehensive database of worker attributes and job characteristics. It is intended as the replacement for the Dictionary of Occupational Titles (DOT).
Opportunity cost: The cost of something in terms of an opportunity foregone. For example, if a person declines to participate in the workforce to go to school or to care for a home or children, the opportunity cost is the earnings or productivity lost by choosing not to work.
Perspective: The point of view an analysis takes, usually from the perspective of society, the employer, or the patient. For example, Social Security disability payments may represent income to the patient and transfer payments to society, and not be a part of the employer's perspective.
Poverty level: 185% of the US Health and Human Services poverty guidelines for the 48 contiguous US states for the years 1998-2003.
Presenteeism: Reduced productivity while working for pay.
Productivity: An individual's work output during a unit of time (usually per hour). Most commonly, health-related productivity is applied to persons who are employed and is often viewed in the context of absenteeism, presenteeism, and compensation.
Productivity loss: The loss of productivity caused by illness. It may be modeled as a function of a person's wage or compensation. Among the methods of defining components of lost productivity are the Human Capital Approach and the Friction Cost Approach. There is considerable controversy as to how to value opportunity costs for individuals.
Retired: Patients who classify themselves as retired whether or not they do work (see definition of work).
Social Security disabled: Persons receiving Social Security disability payments.
Transfer payments: Money given by the government to persons under its jurisdiction. Examples include Social Security, unemployment compensation, welfare, and disability payments.
Wages: Hourly straight-time wage rate or, for workers not paid on an hourly basis, straight-time earnings divided by the corresponding hours.
Working: See employed.

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