Influence of Rheumatoid Arthritis on Employment, Function, and Productivity in a Nationally Representative Sample in the United States

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ABSTRACT. ***Objective.*** The Medical Expenditure Panel Survey (MEPS) was used to estimate the national influence of rheumatoid arthritis (RA) on employment, limitations in work or housework, inability to work or do housework, missed work days, days spent sick in bed, and annual wages.

Methods. MEPS is a nationally representative survey of the US population. Multiple logistic, negative binomial, and Heckman selection regression methods were used, controlling for age, sex, race, ethnicity, smoking status, income, education, and chronic comorbidity. RA was identified using *International Classification of Diseases-9* code 714.

Results. In unadjusted descriptive statistics, individuals with RA were older, had more chronic conditions, missed more work days, spent more days sick in bed, had lower employment rates, had higher rates of limitations and inability to work, and received disability benefits at higher rates. After adjustment, multiple regression analyses showed individuals with RA were 53% less likely to be employed [OR 0.47, 95% CI 0.34–0.65], 3.3 times more likely to have limitations in work or housework (95% CI 2.35–4.64), 2.3 times more likely to be unable to work or do housework (95% CI 1.55–3.53), and spent 3.6 times as many days sick in bed as those without RA (95% CI 2.32–5.53). RA was associated with an expected loss of $8957 in annual earnings (95% CI $1881–$15,937). There was no statistically significant difference in missed work days or the level of wages.

Conclusion. In the most recent available national data for adults, RA was associated with reductions in employment, productivity, and function. (First Release Jan 15 2010; J Rheumatol 2010;37:544–9; doi:10.3899/jrheum.081306)

Key Indexing Terms:
RHEUMATOID ARTHRITIS PRODUCTIVITY FUNCTION
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Rheumatoid arthritis (RA) is a chronic, systemic, and debilitating disease of unknown etiology, characterized by symmetric, erosive synovitis and in some cases, extraarticular involvement[1]. The prevalence of RA in the developed world is about 0.5%–1% of the adult population[2]. In the United States the prevalence of RA in individuals aged 18 years or older is estimated to be 0.6%[2]. The prevalence increases with age and is 2–4 times higher in women than in men, although the women to men ratio decreases with age. Most patients experience a chronic fluctuating course of disease that, despite therapy, may result in progressive joint destruction, deformity, disability, and even premature death[3].

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RA has a deleterious effect on quality of life, employment, function, and productivity[4-6]. In addition, arthritis and other rheumatic conditions have been shown to contribute significantly to direct and indirect costs in the US[7]. Hence it is not surprising that efforts to more aggressively and appropriately treat RA have escalated. In the US, the Healthcare Effectiveness Data and Information Set (HEDIS) recently started tracking the percentage of RA patients treated with disease-modifying antirheumatic drug therapy in a given health plan as an indicator of the quality of care in that health plan. Given the profound impact of RA and the heightened surveillance of its treatment, it is important to assess the current burden of RA in a nationally representative adult population in the United States.

The objective of our study was to examine the effect of RA on employment, functional ability, and productivity in the United States.

MATERIALS AND METHODS

Data source. The Medical Expenditure Panel Survey (MEPS) is cosponsored by the Agency for Healthcare Research and Quality and the National Center for Health Statistics. The MEPS Household Component (HC), a nationally representative survey of the US civilian noninstitutionalized population, collects detailed, self-reported information on demographic characteristics, health conditions, functional limitations, sick days, wages,

income, and employment[8]. MEPS samples a new panel of individuals each year and follows each panel for 2 years, resulting in an overlapping panel design. The sampling frame for the MEPS HC is drawn from respondents to the National Health Interview Survey (NHIS). NHIS provides a nationally representative sample of the US civilian noninstitutionalized population, with oversampling of Hispanics and blacks. Medical condition diagnoses are based on *International Classification of Diseases-9* (ICD-9)-Clinical Modification codes. The sample design of the MEPS-HC survey includes stratification, clustering, multiple stages of selection, and disproportionate sampling. MEPS sampling weights incorporate adjustment for the complex sample design and reflect survey nonresponse and population totals from the Current Population Survey. Further details on the MEPS are available online (www.meps.ahrq.gov).

Study population. Adult (18 years or older) respondents to the 2000, 2002, and 2004 surveys were eligible for this study sample. These survey years were chosen because they were the ones most recently available at the time of study commencement and ensured an adequate sample size. Because MEPS follows individuals for 2 years, pooling consecutive years of data would result in having the same individuals included in the analytical dataset twice. This would not necessarily be problematic because MEPS provides the respective sample and variance adjustment weights to mitigate the duplicate observations. However, for the purpose of our study it was preferred to exclude the duplicated individuals because most of the independent variables used for the regression analyses do not vary across the years. For example, sex, ethnicity, and race do not change, while education, income, and comorbidities remain unchanged for the majority of individuals. Hence the combination of these 3 (2000, 2002, and 2004) annual files avoided the inclusion of duplicate individuals (inclusion of the 2001 or 2003 annual files would have resulted in duplicate individuals). In all analyses, the appropriate probability weights and survey design variables were used to ensure nationally representative results. The resulting cross-sectional data set included 68,666 adult respondents, with 378 individuals with RA (ICD-9 code 714).

Outcomes and variable definitions. The MEPS sample was used to estimate the effect of RA on employment, limitations in work or housework, inability to work or do housework, missed work days (employed individuals only), days spent sick in bed (all individuals), and annual wages. Individuals were identified as having RA based on ICD-9 714, regardless of treatment. Employed individuals were asked in each round how many days (half-day or more) of work they missed because of illness or injury. Individuals were also asked about additional missed days, other than work or school, in which they spent at least half a day in bed because of illness or injury. The latter question is the only measure of lost days for unemployed individuals (e.g., retirees or homemakers). Individuals who were employed at any time during the year were classified as being employed. Annual wages included all income from salary and wages. MEPS also includes specific questions about whether individuals have experienced work or housework limitations (Yes/No) and whether they were unable to work, do housework, or go to school (Yes/No). All variables were reported on an annual basis.

In addition, the statistical analysis adjusted for several comorbidity and sociodemographic characteristics. Education was categorized: high school not completed; high school completed; other degree; bachelor's degree and master's or PhD. Race was categorized as Caucasian, black, American Indian, or other. Age was grouped in the following categories: 18–29 years; 30–39; 40–49; 50–59; 60–69; 70–79; and 80 years or older. Ethnicity was categorized as Hispanic or non-Hispanic. Smoking status included current smoker and not current smoker. In order to control for the effects of chronic comorbidity, a measure of chronic comorbidity was constructed from all reported ICD-9 codes for each individual in MEPS. For this analysis, the total number of reported chronic ICD-9 codes excluding RA were added together to create a count variable called "number of chronic conditions."

Statistical analysis. We used survey estimation software STATA/SE 9.1 to adjust for the complex sample design. All analyses incorporated MEPS sampling and variance adjustment weights to ensure nationally representative estimates. (More specifically, the probability weights from each full-year file and the STRATA and PSU variables from the HC-036 Pooled Estimation Linkage File were used.) All analyses controlled for age, sex, race, ethnicity, smoking status, family poverty category (this variable was excluded in the employment and wage model), education, and chronic comorbidity. The family poverty category variable was excluded from the employment and wage analyses because it can be influenced by the employment and wage-dependent variables (reverse causation).

Employment and limitations. Multiple logistic regression was used to examine the effect of RA on employment, limitations on work or housework, and the inability to do work or housework, controlling for covariates.

Annual wages. Annual wage data exhibit unique statistical properties that require the use of appropriate econometric techniques[9]. For example, wage data is skewed and has a non-negligible percentage of zero wage observations because in a general population sample such as MEPS, many individuals do not earn a wage in a given year (zero wage observations because of unemployment), while a small number of others earn an extremely high wage (hence the right-skewed distribution). The probability of being employed (having a positive wage) is likely to be related to certain characteristics of the individual (i.e., education levels, age, sex, health conditions, etc.). In order to correctly measure the effect of RA and other covariates on annual wages, the econometric estimation method should account for these possible differences between employed and unemployed individuals. Ignoring the effect of these differences on employment or just using the positive wage observations will result in biased estimates. In the literature this is referred to as "selection bias": those who have no earnings are different from those who have positive earnings.

To address this selection bias, Heckman selection models have been developed[10,11]. The Heckman selection model[12,13] has 2 parts: the regression equation and the selection equation.

$$\text{Regression equation: } y_i = x_i\beta + e_{1i}$$

The dependent variable is observed when:

$$\text{Selection equation: } z_i y + e_{2i} > 0,$$

$$\text{where } e_1 \sim N(0,\sigma),\ e_2 \sim N(0,1),\ corr(e_1,e_2) = p$$

This model can be solved by either a 2-step or a maximum likelihood (ML) technique. In this analysis, we used the ML estimation technique. In order to address the skewed distribution of wages, a logarithmic transformation is performed to reduce the influence of very high wage outliers. However, the results of this regression would be expressed in log dollars, which are not intuitive. These log dollars need to be expressed in dollars, but one cannot simply exponentiate the results of the log of wages as usual because this transformation would result in bias[14]. Back-transforming log dollars to dollars using exponentiation produces the geometric mean, which is always lower than (i.e., biased downward from) the arithmetic mean. Hence a "smearing" retransformation is used to transform the "log of wages" back into "wages"[14]. An ML Heckman selection model with logarithmic transformation of wages and Smearing retransformation was used to assess the effect of RA on annual wages in light of selection bias[12,14]. Because many years of data were combined in this analysis, all wage variables were inflated to a common year: $US 2004.

Missed work days. To examine the effect of RA on missed work days and days spent sick in bed also requires econometric methods specific to the count nature of these outcome variables. Poisson or negative binomial regression is typically used for count data analysis[15]. In recent years new extensions, such as zero-inflated Poisson and zero-inflated negative binomial regression methods have been developed to address the count nature of data as well as the big clustering of zero outcome observations[16]. Hence, negative binomial regression and zero inflated negative binomial regression were used to examine the effect of RA on missed work days and days spent sick in bed. The dependent variable in these regressions was missed work days (or days spent sick in bed); the independent variables included RA, age, sex, race, ethnicity, smoking status, family poverty category, education, and chronic comorbidity.

Sensitivity analysis. In addition to multivariate analyses of missed work days, we conducted analyses using propensity score matching to provide further validation of the results of our models[17,18]. The presence of RA was modeled as the treatment variable and the absence of RA was the control variable. Propensity scores were calculated based on the following observed characteristics: age, race, ethnicity, income category, and geographic region. Next, the number of blocks was identified to ensure that the mean propensity score was not different between those with RA versus those without RA within each block. ("Blocks" are groups of observations with similar propensity scores.) The balancing property of the propensity score was satisfied. Finally, for each of the outcomes, the average effect of treatment on the treated was estimated using the Nearest Neighbor Matching method (random draw version)[18].

RESULTS

Unadjusted analyses. There were 378 adults identified with RA and 68,288 adults without RA. The prevalence of RA among adults in MEPS was 0.6%. In unadjusted descriptive statistics, individuals with RA were older, had more chronic conditions, had lower annual wages, missed more work days, spent more days sick in bed, had lower employment rates, and had higher rates of limitations and inability to work or do housework (Table 1). The average annual wage for individuals with RA seems quite low. These values ($24,246 US average and $11,197 for those with RA) may be explained by 2 factors: First, only 33% of individuals with RA were employed (compared to 65% without RA), leading to a much lower average wage for those with RA; second, individuals with RA had a mean age of 58 years compared to 45, which likely also contributes to a lower average wage among those who are working.

Adjusted analyses. After controlling for age, sex, race, ethnicity, smoking status, income, education, and chronic comorbidity, results of the regression analyses showed that individuals with RA were 53% less likely to be employed compared to those without RA (OR 0.47; Table 2): only 30% of individuals with RA were employed after adjustment. With regard to work limitations, multiple regression analysis results indicated that individuals with RA were 3.3 times more likely to report having limitations in work or housework and 2.3 times more likely to report being unable to work or do housework compared to those without RA.

The Heckman selection model has 2 parts: first the selection model, and then the wage equation. The selection model showed that RA was negatively associated with the likelihood of employment ($p = 0.01$); however, after controlling for selection, the coefficient for RA in the wage equation ($3094; Table 2) was not statistically significant ($p = 0.43$). If significant, this coefficient ($3094) would signify the difference in wages attributable to RA (compared to those without RA). These results show that individuals with RA are less likely to be employed, but when employed, they make just as much money as individuals without RA. This finding suggests that the main reason for the unadjusted mean wage difference between RA and non-RA individuals is the large number of unemployed individuals with RA.

One can calculate the expected lost earnings associated with RA using the odds of employment for those with RA versus those without RA and the average annual earnings. First, the Heckman selection model with smearing retransformation estimates the average annual earnings in MEPS for all employed individuals to be $49,624. The probability of being employed in the group of individuals without RA in the US is 0.65 (Table 1: 0.65 is the unadjusted percentage of individuals without RA who are employed; the odds are $0.65/0.35 = 1.86$). The adjusted probability of being employed for those with RA in the US is 0.47 (0.47 is the adjusted odds ratio of being employed for those with RA compared to those without RA from Table 2; $0.47 \times 1.86 = 0.873$, the odds of being employed for those with RA). The expected annual earnings for those without RA are $0.65 \times \$49,624 = \$32,256$, while the expected annual earnings of those with RA are $0.47 \times \$49,624 = \$23,323$. Hence, RA is associated with an adjusted expected loss of $8957 (st err

Table 1. Unadjusted descriptive descriptive statistics: individuals with and without rheumatoid arthritis (RA) in the MEPS 2000, 2002, and 2004 (age ≥ 18 yrs).

Measure	US Average	Without RA*	With RA (ICD-9 714)*
Number**	68,666	68,288	378
Age	45.4	45.3	57.8
No. missed work days (employed)	4.5	4.5	7.9
Additional no. of days spent in bed sick (other than work/school)	6.2	6.1	29.7
% employed	65	65	33
Annual wage (2004 dollars)	$24,246	$24,322	$11,197
% having any limitations in work, housework, or school	09	09	41
% unable to work, do housework, or go to school	06	05	25
Total number of chronic conditions	1.8	1.8	5.1

* Unadjusted means. **Totals may not add up because of MEPS survey weights. MEPS: Medical Expenditure Panel Survey; ICD-9: *International Classification of Diseases*.

Table 2. Results of the multiple regression analyses: individuals with RA compared to those without RA. All analyses controlled for age, sex, race, ethnicity, smoking status, family poverty category (this variable was excluded in the employment and wage models), education, and chronic comorbidity.

Characteristic		95% CI
Likelihood of being employed, odds ratio	0.5*	0.34–0.65
Likelihood of having any limitations in work or housework, odds ratio	3.3*	2.35–4.64
Likelihood of being unable to work or do housework, odds ratio	2.3*	1.55–3.53
No. of missed work days (employed), incident rate ratio	1.0	0.54–1.74
No. of days spent in bed sick (other than work/school: employed and unemployed), incident rate ratio	3.6*	2.32–5.53
Annual wages, 2004 dollars**	3094	–4,678 to 10,865

* Statistically significant ($p < 0.05$). ** For employed individuals (Heckman selection model incorporates the likelihood of being employed).

$3748; 95% CI $1881–$15,937) in annual earnings. The unadjusted difference in wages from Table 1 is $13,125, but this unadjusted difference does not control for important factors such as older age, which would tend to make the wages for individuals with RA lower.

Missed work days. The total number of days spent sick in bed was available for both the employed and unemployed population. The results showed that individuals with RA spent 3.6 times as many days in bed as those without RA after controlling for covariates (Table 2). Considering that the unadjusted average number of days spent sick in bed (other than work or school) was 6.08 for those without RA, individuals with RA spent 21.7 days sick in bed (3.58×6.08), or about 16 days more than those without RA. However, there was no statistically significant difference in missed work days for employed adults with RA compared to employed adults without RA.

Results of the propensity score matching analysis were consistent with the multiple regression analyses. Among employed responders, there was no statistically significant difference between those with RA and those without RA in the number of missed work days. However, similar to the multiple regression analyses, those with RA spent an average of 19.7 more days sick in bed (other than work or school) than those without RA ($p < 0.05$).

DISCUSSION

The results of our study show that in the MEPS data in the US, RA was associated with a significantly lower likelihood of employment, increased days spent sick in bed, and decreased ability to perform work/housework functions. However, in analyses restricted to the small population of employed individuals with RA, there was no statistically significant difference in the number of missed work days or the level of wages compared to employed individuals without RA.

Only 2 nationally representative data sets that contain productivity information are currently available (MEPS and NHIS). In our research, we used 3 years of data to identify an adequate sample of individuals with RA. There have been several studies documenting the deleterious effect of arthritis and other rheumatic conditions on employment, functional limitations, and productivity, but most of these studies have not focused on RA and/or have not been conducted in a nationally representative adult population in the US. In addition, most previous studies have not examined the likelihood of employment separately from estimates of earnings losses among those who are employed. Yelin, *et al* examined medical expenditures and lost wages in a combined group of individuals with arthritis and other rheumatic conditions in the MEPS[19]. They found that people with these conditions (aged 18–64 years) earned $3613 (in 2003 dollars; $3772 in 2004 dollars) less than individuals without the conditions. Of this amount, $1590 ($1700 in 2004) was attributable to arthritis and other rheumatic conditions. Subsequent work by Yelin using the MEPS estimated annual earnings losses attributable to RA to be $6414 (in 2004 dollars) annually[20]. Differences in the statistical methodology and models between the work by Yelin, *et al* and our study may account for some of the difference in estimates (for example, our study included smoking as an independent variable while Yelin, *et al* did not). There are also several other nationally representative studies examining the effect of arthritis on productivity and employment that did not restrict their analyses to RA[21-26]. In addition, our study did not examine the effect of RA on medical expenditures. It would be beneficial for future analyses to examine the effect of RA on medical expenditures and compare this to the results found by Yelin, *et al* among those with arthritis and other rheumatic conditions.

Burton, *et al* reviewed multinational articles examining the effect of RA on work loss and disability among patients diagnosed with RA who were gainfully employed[4]. The literature search was restricted to the employed population with clearly defined RA. They found that work loss was experienced by 36%–84% of employed individuals with RA, resulting in a median loss of 39 days annually. Cohort studies showed that the time from RA onset to 50% proba-

bility of being permanently work-disabled varied from 4.5 to 22 years. Unsurprisingly, they found that characteristics that were associated with work disability included physically demanding occupation, more severe RA, and older age. However, they concluded that disease status ultimately determined work disability. Although it provides important information, the results included in Burton, *et al*'s review are not comparable to our analysis of a generic population of individuals with RA (e.g., our sample includes unemployed individuals). Wolfe, *et al* examined patients with RA who were followed by a rheumatologist and imputed the estimated earnings losses based on sociodemographic characteristics[27]. They found that annual earnings losses ranged between $2319 and $3407 ($US 2002; $2518–$3699 in 2004). Only 26% of the studied population was employed, compared to 30% in our study. The study by Wolfe, *et al* differs from our study in that they projected earnings losses for the population with RA from external sources of wage information rather than estimating actual earnings losses. In addition, the population studied was more severe (rheumatology patients) compared to our general population sample.

Research has documented the deleterious effect of arthritis and RA on earnings and disability. By examining the effect of RA on employment, productivity, and function in a nationally representative adult general population, including employed and unemployed as well as all degrees of disease severity, our results contribute to this body of knowledge.

This research is not without limitations. The results of our study are generalizable to the United States, but may not be relevant for other national populations. The current study found the prevalence of RA in US adults was 0.58%. This is comparable to recent estimates by Lawrence, *et al*, who estimated that the doctor-diagnosed RA in the US was approximately 0.6%[2]. Nonetheless, prevalence rates in MEPS typically may underestimate national prevalence. Similar to the Behavioral Risk Factor Surveillance System and the NHIS, MEPS is based on self-report. Research has shown that self-reported conditions may be underreported and the extent may vary by race and ethnicity. The misclassification of RA based on self-report is a threat to the validity of the results of our study. Research has questioned the sensitivity of self-reported RA[28,29]. Although our estimates of national prevalence seem consistent with other national prevalence data, it is not clear whether self-reported RA in MEPS is validly classified. The extent to which individuals do not accurately self-report RA in MEPS may result in diminishing the effect of RA: in other words, because the RA group and the comparison group (those without RA) would become more similar if RA is misclassified, the magnitude and statistical significance of the effect of RA on outcomes may be reduced. In contrast, it is possible that misclassification could overestimate the effect of RA: for example, if only those patients with severe RA report having RA. As a result, our estimates may be biased to a commensurate degree. Another limitation may derive from the framing of certain questions in MEPS: the questions related to work or housework would not be sensitive to limitations for individuals with RA who do not work or do housework.

The study design was a retrospective cross-sectional data analysis. True causal relationships cannot be determined; however, the study questions would not be appropriate for a prospective randomized trial. While MEPS is the most appropriate data set for the given study questions, *a priori* sample size planning is not feasible in a retrospective data analysis.

The lack of statistically significant difference in missed work days and the level of wages among employed individuals with RA is surprising. The sample of individuals who were employed and had RA was quite small because the employment rate was so much lower. Our results of the likelihood of employment showed that individuals with RA were 53% less likely to be employed than individuals without RA, after controlling for age, sociodemographic characteristics, and comorbidity. Incorporating this OR with the unadjusted employment rate among those without RA suggests that only 30% of individuals with RA were employed (after controlling for the effects of age, other sociodemographic characteristics, and comorbidity). Hence, while the sample size was sufficient to draw national conclusions, it was relatively small; there were only 119 employed individuals out of a sample of 378 individuals with RA. The different results of the missed days variables suggest that the lower likelihood of retaining employment could be driving the results. The number of days spent sick in bed was asked of all individuals (employed and unemployed). RA was associated with a statistically significant increase in days spent sick in bed (3.58 times as many as those without RA). However, the number of missed work days variable was asked only of those who were employed. In this case, RA was not associated with a statistically significant difference in missed work days. However, individuals with RA were 53% less likely to be employed. It seems peculiar that individuals who suffer from RA would be more likely to spend days sick in bed and would be less likely to be employed, but not more likely to miss work days when employed. This difference may stem from the fact that employed individuals with RA, by nature of their ability to find and maintain employment, have less severe or better-controlled RA. This may be particularly plausible in this study population, which includes a general sample of individuals of all levels of severity, including total remission, compared, for example, to more severe study populations with inclusion criteria limited to patients who are followed by a rheumatologist or have specific markers of severity. This nonsignificant finding could also be due to inadequate sample size/power. However, our results are consistent with Ozminkowski, *et al*, who showed that the percentage of employed individuals with RA experiencing absenteeism from work was actually

lower than for those without RA[6]. They hypothesized that patients with more severe RA may be more likely to leave the workforce, leaving only those patients with less severe RA employed, and they may be less likely to experience increased absenteeism. Our results would support this possibility. They also suggested that RA patients may be more likely to suffer from presenteeism rather than absenteeism. Similar to Ozminkowski, *et al*, our study did not measure severity of RA or presenteeism, but this would be an important area for future research.

Despite these limitations, our results show the deleterious effects of RA on employment, productivity, and function. RA was clearly associated with a burden on the US economy via lost earnings and productivity. This effect was most clearly evident in the significantly lower adjusted likelihood of being employed. In addition, however, it is important to consider the human toll that RA exerts outside the typical measures of disease burden in economic terms. The human capital approach would suggest that the economic effect of RA should be limited to lost wages for those who are employed and who missed work and/or experienced reduced productivity while working. However, the results of our study showed the burden of RA on function as well as days spent sick in bed for both employed and unemployed individuals. Significantly more individuals with RA were completely unable or limited in their ability to do work or housework. In addition to the obvious economic toll, these "social costs" are significant in their own right. Successful control of disease symptoms should be the goal of treatment and may mitigate the sizable burden of RA on the US population from reduced productivity and function.

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