ONLINE FIRST

The Cumulative Effect of Unemployment on Risks for Acute Myocardial Infarction

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Background: Employment instability is a major source of strain affecting an increasing number of adults in the United States. Little is known about the cumulative effect of multiple job losses and unemployment on the risks for acute myocardial infarction (AMI).

Methods: We investigated the associations between different dimensions of unemployment and the risks for AMI in US adults in a prospective cohort study of adults (N=13,451) aged 51 to 75 years in the Health and Retirement Study with biennial follow-up interviews from 1992 to 2010. Unadjusted rates of age-specific AMI were used to demonstrate observed differences by employment status, cumulative number of job losses, and cumulative time unemployed. Cox proportional hazards models were used to examine the multivariate effects of cumulative work histories on AMI while adjusting for sociodemographic background and confounding risk factors.

Results: The median age of the study cohort was 62 years, and 1061 AMI events (7.9%) occurred during the 165,169 person-years of observation. Among the sample, 14.0% of subjects were unemployed at baseline, 69.7% had 1 or more cumulative job losses, and 33.1% had spent time unemployed. Unadjusted plots showed that age-specific rates of AMI differed significantly for each dimension of work history. Multivariate models showed that AMI risks were significantly higher among the unemployed (hazard ratio, 1.35 [95% CI, 1.10-1.66]) and that risks increased incrementally from 1 job loss (1.22 [1.04-1.42]) to 4 or more cumulative job losses (1.63 [1.29-2.07]) compared with no job loss. Risks for AMI were particularly elevated within the first year of unemployment (hazard ratio, 1.27 [95% CI, 1.01-1.60]) but not thereafter. Results were robust after adjustments for multiple clinical, socioeconomic, and behavioral risk factors.

Conclusions: Unemployment status, multiple job losses, and short periods without work are all significant risk factors for acute cardiovascular events.

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According to the US Department of Labor, most adults will have had multiple jobs by middle age, and most will have had 1 or more periods of unemployment. Although recent research has shown that job loss at older ages substantially increased risks of AMI, the longitudinal evidence linking unemployment to cardiovascular events has been limited and inconclusive. The purpose of the present study was to extend these findings and provide the first prospective investigation of the short- and long-term effects of multiple dimensions on risks for AMI. We used data from a nationally representative sample of middle-aged and older adults followed up biennially from 1992 to 2010 to examine the effect of unemployment status, cumulative job losses, and duration of unemployment on risks for AMI. The

MORE THAN 1 MILLION Americans experienced a first or a recurrent acute myocardial infarction (AMI) in 2010, and more than half died as a result. Although major risk factors for coronary heart disease have been well documented (eg, inactivity, obesity, hypertension), the effect of social stressors on AMI are still poorly understood. For more than a century, studies have shown that the lack of employment is a direct or indirect risk factor for poor health. Unemployment has now been linked to a myriad of risk factors and deficient resources that may contribute to elevated rates of cardiovascular disease. To date, however, the evidence has been based almost entirely on cross-sectional associations that ignore lifetime variability in employment, with its immediate and long-term consequences for cardiovascular health.
associations were examined with adjustments for multiple socioeconomic, behavioral, psychological, and clinical factors. We also examined whether the associations between job instability and AMI risk differed by sex and race/ethnicity.

**METHODS**

**STUDY POPULATION**

We used nationally representative data from the Health and Retirement Study (HRS) for analysis. The HRS is an ongoing prospective cohort study of US adults older than 50 years sponsored by the National Institute on Aging and the Institute for Social Research at the University of Michigan, Ann Arbor. The original HRS cohort included 9824 age-eligible respondents (ie, ages 51-61 years) who have been interviewed biennially since 1992. The initial participation rate was 81.7%, and recontact and response rates have been documented in detail elsewhere.

The analytic sample for the study included 13,451 participants from the original HRS birth cohort (1931-1941), the war baby cohort (1942-1947), and early baby-boomer cohort (1948-1953) who were first interviewed in 1992, 1998, and 2004, respectively, and reinterviewed through 2010. A person-year file was constructed from the respondents’ age-specific cumulative exposure to AMI so that each observation was a record for every additional year beyond their age at entry in the study. Analyses were restricted to adults aged 51 to 75 years who reported having ever worked (95.8%). On average, HRS participants contributed approximately 8 person-years of exposure during the 18-year study period. A total of 1061 AMI events (7.9%) were reported during the 163,169 person-years of observation.

**MEASUREMENT**

We used more than 50 years of prospective and retrospective data from the HRS to reconstruct employment histories for each study participant. Information about past employment was collected at the respondents’ baseline interview, and information about current jobs (and changes) was obtained from the prospective interview. Work-history timing was ascertained from detailed responses to questions about the beginning and ending dates of employment statuses. Retirement status (with or without active employment) also was included as a time-varying covariate. The analytic sample for the study included 13,451 participants from the original HRS birth cohort (1931-1941), the war baby cohort (1942-1947), and early baby-boomer cohort (1948-1953) who were first interviewed in 1992, 1998, and 2004, respectively, and reinterviewed through 2010. A person-year file was constructed from the respondents’ age-specific cumulative exposure to AMI so that each observation was a record for every additional year beyond their age at entry in the study. Analyses were restricted to adults aged 51 to 75 years who reported having ever worked (95.8%). On average, HRS participants contributed approximately 8 person-years of exposure during the 18-year study period. A total of 1061 AMI events (7.9%) were reported during the 163,169 person-years of observation.

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Outcome

Incidence of AMI was the main outcome for analysis. Study participants were asked whether they had “a heart attack or myocardial infarction” at each interview and in what year (and month after 1994) it occurred. Although subjects’ reports of AMI are less precise than clinical data, studies have shown considerable consistency between diagnostic reports of health events from survey respondents and those from medical evaluations. The short time between interviews (approximately 24 months) and the life-threatening nature of these events also minimized the potential for recall bias. For persons who experienced AMI, the outcome corresponds to the age of the event (calculated from the dates of birth and the event). For persons not experiencing AMI, the outcome corresponds to the age when respondents were last observed to be free of disease. Forty-one adults reported an AMI before baseline and were excluded. Three hundred twenty-nine subjects (2.4%) died during the study and were censored at their age of death. Of the 1061 AMIs, 92 (8.7%) were reported at ages that were difficult...
to distinguish temporally from the time of job loss. However, by design, the time-varying measures of job loss were time lagged to ignore job losses that were reported concurrently with AMI exposure to unemployment and AMI events. The number of tied events relative to the number at risk was low (<1%), and partial likelihood estimation was nearly identical using Breslow (reported herein) and Efron approximations.

The first set of multivariate models examined the unadjusted associations for each of the 3 groups of work-history measures and AMI and adjusted associations that included age, sex, race/ethnicity, marital status, retirement, and geographic region. The second set of multivariate analyses examined the associations for all the work-history variables and AMI while adjusting for age, sex, race/ethnicity, marital status, retirement, and region. A final model adjusted for the confounding effects of additional cardiovascular risk factors. Variance inflation factors, tolerance levels, and condition values were used to confirm the absence of multicollinearity in the fitted models.

Interactions also were examined by sex and race/ethnicity. Multivariate models were adjusted for the complex HRS sampling design to produce unbiased variance estimates. Tests of
Characteristics of the study participants are presented in Table 1. Adults who had an AMI were more likely to be older, male, non-Hispanic, and living in the South than those without an event. Those who had low levels of education and income, had no health insurance, smoked, abstained from alcohol, failed to exercise, were overweight or obese, had been diagnosed with hypertension or diabetes mellitus, were disabled in their activities of daily living, or had depressive symptoms also had substantially higher levels of AMI than their counterparts. Rates of AMI were significantly higher in study participants who were unemployed and retired compared with employed participants (P < .001). Distributions of AMI were not significantly different for the cumulative number of job losses (P = .31), and there was an inverse trend between cumulative time unemployed and AMI (P = .007).

Unadjusted plots shown in Figure 1 demonstrate significant differences (P < .001) in age-specific rates of AMI for each time-varying dimension of job history. Figure 2 illustrates the unadjusted and sociodemographically adjusted HRs for the 3 work-history components related to AMI. Results showed that each major dimension of employment instability was significantly associated with incident AMI after adjusting for differences in age, race/ethnicity, marital status, retirement, and geographic region.

Table 2 reports the sociodemographically and fully adjusted associations between all the work-history variables and AMI. The initial model showed that unemployment status, cumulative number of job losses, and cumulative time unemployed were all associated with AMI independent of the other work-history dimensions. Model adjustments for sociodemographic, socioeconomic, behavioral, psychological, and clinical risk factors did not attenuate these effects. The fully adjusted model showed that unemployment status (HR, 1.35 [95% CI, 1.10-1.66]) and 1 (1.22 [1.04-1.42]), 2 (1.27 [1.05-1.54]), 3 (1.52 [1.22-1.90]), and 4 or more cumulative job losses (1.63 [1.29-2.07]) were independently associated with incident AMI. Risks of AMI were significantly elevated within the first year of being out of work (HR, 1.27 [95% CI, 1.01-1.60]) but not after longer periods of unemployment. The multivariate findings were significant and comparable to other major risk factors in the model, such as smoking (HR, 1.44 [95% CI, 1.24-1.68]), diabetes mellitus (1.51 [1.30-1.75]), and hypertension (1.62 [1.42-1.86]).

Although the magnitudes of the HRs were generally greater among men, Hispanics, and non-Hispanic blacks than among women and non-Hispanic whites, none of the interaction terms for sex and race/ethnicity were statistically significant.

Our study is the first, to our knowledge, to examine the cumulative effect of multiple dimensions of unemployment in US older adults. A, Employment status (unemployed excludes retired). B, Cumulative number of job losses. C, Cumulative time unemployed. P values are based on log-rank tests for group differences.
losses were of the magnitude of other traditional risk factors, such as smoking, diabetes mellitus, and hyperten-
sion. In the context of the current US economy and pro-
jected increases in job instability and unemployment among workers, additional studies should investigate
the mechanisms contributing to work-related dispari-
ties in AMI to identify viable targets for successful interventions.

The present study demonstrates that cumulative ex-
posure to unemployment increased risks for AMI and that the associations were not accounted for by conventional so-
cial, behavioral, psychological, or clinical factors. Overall,
our results remained robust after adjustments for more than a dozen confounding factors. In addition, we found no ev-
idence that differences in occupational status or time of en-
try in the workforce (because of educational level, chil-
dren, and/or health status) were related to the incidence of AMI when the 3 dimensions of employment history were taken into account. These findings were consistent in men
and women and major race/ethnic groups, and they corre-
orborate recent evidence linking involuntary job loss and AMI in older adults.

The findings for the longitudinal association bet-
tween employment instability and AMI complement and
extend our understanding of lifetime exposure to car-
diovascular risks. The association between job loss and AMI is analogous to risks attributable to smoking. Al-
though current smoking status is a known risk factor for
cardiovascular events, long-term patterns of tobacco use
(i.e., pack-years) are more powerful predictors of risk. Likewise, the onset of hypertension or type 2 diabetes mellitus does not increase the risk for AMI; instead, the strain that these illnesses exact on the cardiovascular system over time increases the risk. Our findings for em-
ployment history largely mirror these protracted and cu-
mulative associations.

Eliminating or lessening exposure to acquired risk fac-
tors undoubtedly reduces their toll on health outcomes, although lifetime risks may persist. Smoking cessation, for example, reduces the risk for AMI; however, it does not eliminate the effect of total pack-years of tobacco use. Likewise, reemployment may only in part di-
minish the negative effects of past disruptions and com-
mensurate losses. An important area for future research
will be to identify the extent to which reducing long-
term exposure to risk factors lowers the odds of AMI and other health outcomes. A related line of inquiry should in-
vestigate whether unemployment earlier in adult-
hood can be ameliorated by biomedical, psychological,
and social resources acquired later in life.

Major strengths of this study included the use of panel
data from a large representative sample of middle-aged
and older US adults, the use of retrospective histories and
prospective data spanning almost 20 years, and multi-

Table 2. HRs for Acute Myocardial Infarction Associated
With Employment Status, Cumulative Job Losses, and
Cumulative Time Unemployed in 13 451 US Older Adults

<table>
<thead>
<tr>
<th>Employment status</th>
<th>Adjusted Model</th>
<th>Full Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazard Ratio</td>
<td>1.00 [Reference]</td>
<td>1.00 [Reference]</td>
</tr>
<tr>
<td>Retired</td>
<td>1.20 (0.97-1.48)</td>
<td>1.20 (0.97-1.48)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>1.74 (1.42-2.14)</td>
<td>1.35 (1.10-1.66)</td>
</tr>
<tr>
<td>Employed</td>
<td>1.00 [Reference]</td>
<td>1.00 [Reference]</td>
</tr>
<tr>
<td>Cumulative No. of job losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1.00 [Reference]</td>
<td>1.00 [Reference]</td>
</tr>
<tr>
<td>1</td>
<td>1.19 (1.02-1.39)</td>
<td>1.22 (1.04-1.42)</td>
</tr>
<tr>
<td>2</td>
<td>1.24 (1.03-1.50)</td>
<td>1.27 (1.05-1.54)</td>
</tr>
<tr>
<td>3</td>
<td>1.47 (1.16-1.83)</td>
<td>1.52 (1.22-1.90)</td>
</tr>
<tr>
<td>4</td>
<td>1.62 (1.28-2.05)</td>
<td>1.63 (1.29-2.07)</td>
</tr>
<tr>
<td>Cumulative time unemployed, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1.00 [Reference]</td>
<td>1.00 [Reference]</td>
</tr>
<tr>
<td>&gt;0 to 1</td>
<td>1.35 (1.07-1.69)</td>
<td>1.27 (1.01-1.60)</td>
</tr>
<tr>
<td>2 to 4</td>
<td>1.08 (0.89-1.31)</td>
<td>0.96 (0.79-1.17)</td>
</tr>
<tr>
<td>5</td>
<td>1.05 (0.87-1.26)</td>
<td>0.90 (0.74-1.09)</td>
</tr>
</tbody>
</table>

Abbreviation: HR, hazard ratio.

Adjusted for age, sex, race/ethnicity, marital status, and geographic region.

Adjusted for variables in the first model and educational level, income, health insurance, smoking, alcohol use, physical exercise, cholesterol screening, body mass index, hypertension, diabetes mellitus, activities of daily living disability, and Center for Epidemiologic Studies Depression Scale depressive symptoms.

Figure 2. Risks for acute myocardial infarction by employment status, cumulative number of job losses, and cumulative time unemployed in US older adults (N = 13 451). Hazard ratios are adjusted for age, sex, race/ethnicity, marital status, retirement, and geographic region. Error bars indicate 95% confidence intervals.
variate hazards models that used time-varying covariates to estimate risks for AMI. Nonetheless, the study was not without limitations. Although the data were rich in the number and scope of measured covariates, we lacked data on certain clinical factors. For example, data were not available for the treatment and control of hypertension, diabetes mellitus, and hyperlipidemia before AMI or other prophylactic measures to reduce the likelihood of infarction (eg, prior revascularization). We also could not identify the characteristics of all jobs and the reasons for job loss. Studies have shown that the nature of work (eg, job strain and decision latitude) plays a role in the association between employment and AMI.68,69 Although detailed measures of employment characteristics were not available, preliminary analyses showed that primary lifetime occupation had no effect on the findings. In addition, results indicated that voluntary transitions out of work (ie, retirement) were not associated with increased AMI, independent of age, health status, and other confounders. Future studies should consider whether other job-related factors (eg, seasonal employment, underemployment, multiple jobs, or family demands) may be sources of employment instability, stress, and increased cardiovascular events. The timing of job loss (eg, young vs old or in the context of family) is an additional dimension of unemployment that warrants investigation. Finally, although this study adjusts for a number of confounding risk factors, additional studies should examine the mechanisms by which different dimensions of employment history affect AMI at older ages.

RESULTS

Conclusions

Results from our large prospective cohort study demonstrated the powerful effect of one's lifetime employment history and cumulative job losses on risks for a major cardiovascular event. As rates of job instability continue to increase and unemployment reaches 30-year highs after recent constrictions to the US economy,26,28,29 the cardiovascular costs of repeated job losses in younger cohorts are yet unknown. Although employment background is not amenable to medical intervention, knowledge about employment status, number of job losses, and the amount of time unemployed may help to identify individuals at elevated risk for AMI. Additional studies are needed to assess how such information can be used to target and aggressively treat vulnerable segments of the population.

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Author Contributions: Dr Dupre had full access to the data in the study and takes responsibility for the accuracy of the data analysis. Study concept and design: Dupre and George. Acquisition of data: Dupre and Peterson. Analysis and interpretation of data: Dupre, George, Liu, and Peterson. Drafting of the manuscript: Dupre. Critical revision of the manuscript for important intellectual content: Dupre, George, Liu, and Peterson. Statistical analysis: Dupre, Liu, and Peterson. Administrative, technical, or material support: George. Supervision: Dupre and Peterson.

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