

# Chronic Diseases and Functional Limitations Among Older Construction Workers in the United States: A 10-Year Follow-up Study

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**Objectives:** To examine the health status of older construction workers in the United States, and how occupation and the aging process affect health in workers' later years. **Methods:** We analyzed six waves (1998 to 2008) of the Health and Retirement Study, a longitudinal survey of US residents age 50+. The study sample totaled 7200 male workers (510 in construction trades) in the baseline. Multiple logistic regression and paired *t* tests were conducted to compare health outcomes across occupations and within individuals over time. **Results:** Compared with white-collar workers, construction workers had increased odds of arthritis, back problems, chronic lung disease, functional limitations, work disability, and work-related injuries after controlling for possible confounders. **Conclusions:** Safety and health interventions, as well as retirement and pension policy, should meet the needs of older construction workers, who face increasingly chronic health conditions over time.

The US workforce is aging. According to the Bureau of Labor Statistics, workers over the age of 55 have increased dramatically from 17 million to 27.9 million in 2008 and are expected to grow to nearly 40 million in 2018.<sup>1</sup> Following this trend, the average age of construction workers increased to more than 40 in 2008; nearly 5 years older than it was two decades ago.<sup>2</sup> Age is a major factor for worker safety and health, especially for physically demanding industries and occupations such as construction.

The exposure hazards in the construction industry and their association with health outcomes are well documented.<sup>3–10</sup> For example, construction was the most frequently listed industry on asbestosis and silicosis death certificates (24.6% and 13.4%, respectively) from 1990 to 1999.<sup>11</sup> Construction workers are more susceptible to chronic lung disease (CLD), asthmatic symptoms, and parenchymal diseases from on-the-job exposure to dust, asbestos or silica, and nonsensitizing agents.<sup>12–14</sup> Older construction workers at Department of Energy Nuclear Sites showed a large excess of lung cancer.<sup>15</sup> Other negative health outcomes, such as tumors, circulatory disorders, bone and joint diseases, and nontransport injuries have also been found to be associated with exposure to hazardous substances at construction sites.<sup>16–20</sup>

In addition to hazards at the workplace, some behaviors such as smoking and alcohol abuse can impair the ability of workers to perform their duties; reduce the effectiveness, and productivity of workers; increase injuries and illnesses, and employee absenteeism; and pose a significant risk to site management and coworkers.<sup>21–25</sup> Among construction workers, heavy smoking, combined with occupational exposure, appears to have a dose-response relationship to occupational disability, particularly disability due to respiratory and cardiovascular diseases, mental health disorders, and cancer.<sup>26</sup>

Obesity can also exacerbate likelihood of disability among construction workers, particularly decreased work capacity due to osteoarthritis and cardiovascular disease.<sup>27</sup>

As the workforce continues to grow older, the matter of how to sustain “workability” has attracted public attention.<sup>28</sup> There is some evidence that chronic diseases and functional impairment cause serious limitations for construction work as workers age.<sup>20,29</sup> Researchers have found that construction workers experience relatively earlier onset and more severe osteoarthritis<sup>30</sup> and more severe work disability compared with other occupations.<sup>31</sup> Although a major battle against work disability is in physical health, mental health problems—including depression and anxiety—are also common causes of work disability.<sup>32</sup>

In spite of these numerous studies addressing health issues among construction workers, we still lack a clear picture of how occupational experience contributes to health and illness in workers' later life, in particular the development of chronic illnesses and the decline of functional abilities. Such research has included brief or no follow-up, examined groups outside of the United States, and largely been restricted to small samples. Monitoring health status, workability, and limitations of older workers is important for workplace safety and health, and critical for individual workers, their families, employers, and society. A longitudinal examination of a national US sample of workers would facilitate a more thorough analysis of the relationship between occupational exposures and downstream health problems; such a study could fill in our current knowledge gaps.

## METHODS

### Data Source and Sample Size

We analyzed six waves of the Health and Retirement Study (HRS) from 1998 to 2008. The HRS is a large nationally representative longitudinal survey of US residents older than 50 years. The HRS has been conducted by the Survey Research Center at the University of Michigan with sponsorship by the National Institute on Aging since 1992. The initial 1992 HRS contained 12,652 people, who were born between 1931 and 1941.<sup>33</sup> Several age cohorts have been added to the HRS in the waves since then.<sup>34–37</sup> We used the RAND HRS data files, which the RAND Center for the Study of Aging has produced through data cleaning and processing for maximum comparability across waves.<sup>38</sup> Regarding the HRS variables not included in the RAND data files, they were extracted from the original HRS files by linking survey ID and survey wave between the files.

We selected the 1998 wave as the baseline year to obtain a relatively large sample and sufficient follow-up period. We restricted our analysis sample to HRS male respondents because there were too few females in construction trades. The male respondents could be currently working, unemployed, or retired, but had to report their longest job in the baseline interview. Nearly half (49%) of this selected group belonged to the original HRS cohort, and 31% were from the War Baby cohort (born in 1942 to 1947), 11% from the Children of Depression cohort (born in 1924 to 1930), and 9% from the Asset and Health Dynamics Among the Oldest Old cohort (born

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in 1923 or earlier). In 2008, about 62% of the selected respondents were still alive, noninstitutionalized, and not lost to follow-up. Overall, the study sample consisted of 34,044 person-wave observations contributed by 7200 unique individuals. Of this group, 7% (510 respondents) reported that their longest job was in construction trades at baseline, representing a sample-weighted 1.85 million construction workers in 1998. Over the course of the study period, these 510 individuals contributed 2390 person-wave observations. Detailed information, such as sampling, weights, and definitions of variables in each wave, are publicly accessible and can be found on the HRS Web site, <http://hrsonline.isr.umich.edu>.

## Definitions and Measures

Occupation categories in 1998 were based on the three-digit 1980 US Census Occupation Codes. *Construction workers* refer to respondents whose current or longest job was in construction trades in the baseline survey (codes 553-617). Other *blue-collar workers* included mechanics or repair personnel, precision production workers, and operators (eg, machine, transport, and handlers; codes 473-549, 628-889). (About 9% of these other blue-collar workers reported being employed in the construction industry in the baseline year.) Managerial and professional occupations, clerical, and administrative support were combined as *white-collar workers* (codes 003-235; 303-389). Demographics, employment, and health outcomes among construction workers were compared with *other blue-collar workers* and *white-collar workers*, respectively. Respondents in service and sale occupations were excluded in the comparisons, but included in the total study sample.

Health conditions were measured in different ways, including both subjective (respondent's perceived status) and objective (doctor-diagnosed) measures. First, we examined self-reported change in health across the study period. Starting in the second interview, the HRS respondents are asked in each of the follow-up interviews, "Compared with your health when we talked with you in [month and year of last interview] would you say that your health is better now, about the same, or worse?" Respondents reporting either better or worse health are probed further, "much better (worse)," or "somewhat better (worse)?" The scoring that combines these questions includes: much better (1), somewhat better (2), same (3), somewhat worse (4), and much worse (5). The mean of the responses was calculated and compared wave to wave. We then examined individual health conditions. A prevalence measure of selected conditions was based on questions asking whether the respondent had been ever told by a doctor that he had the medical condition (except for back pain, which was by self-reported symptoms). Perceived physical health and hearing were measured by binary variables derived from five-point scale variables: if the respondent perceived status was either "fair" or "poor," it was recoded to 1; otherwise, it was 0. Mental health was measured using a scale based on the Center for Epidemiologic Studies Depression screening tool, eight-item instrument (CES-D 8); a score of 3 or higher (indicating a report of at least 3 of 8 problems) was recoded to 1, while a score of 0 to 2 was recoded to 0. Functional limitations in four domains were measured: stoop/kneel/crouch; reach/extend arms up; push/pull large object; and lift/carry 10 pounds. The responses were dichotomized, where 1 denotes "some difficulty" (from "a little" to "very difficult/can't do"), while 0 denotes "not difficult at all." The measure of work-related injuries was derived from two questions: Whether the health problem was the result of an injury, and whether the injury was related to work. Obesity was measured using the Centers for Disease Control and Prevention guideline of body mass index (BMI)  $\geq 30$ .<sup>39</sup> Measures of fair/poor hearing and work limitation were included as well. Selected health behaviors (such as smoking, heavy drinking, e.g., 3 per day or more, or use of preventive care) were also assessed.

## Data Analysis

The prevalence of chronic diseases and functional limitations was estimated and compared between the baseline and the 10-year follow-up wave. Paired *t* tests were conducted to measure whether an individual respondent's health conditions in the follow-up years were different from the baseline survey. Stratified analyses investigated health conditions in each work group at both baseline and follow-up. Logistic regression models, adjusted for the effects of age, race/ethnicity, marital status, census region, BMI, smoking, and heavy drinking, assessed the significance of differences in health outcomes between worker groups. The respondent level weight variable was used in the analyses. This weight variable is nonzero for living noninstitutionalized respondents born in the appropriate years and is zero for nonrespondents, deceased respondents, and respondents residing in nursing homes. It is scaled so as to yield weight sums which correspond to the number of individuals in the US population as measured by the March Current Population Survey for the year of data collection.<sup>40</sup> The sample weights, primary sampling unit markers, and strata markers of the HRS were applied in all data analyses according to the special survey design. SAS (version 9.2) survey procedures, which accounted for the complex, multistage sampling design of the HRS, were used in conducting the data analyses.

## RESULTS

### Characteristics at 1998 Baseline and 2008 Follow-up

Tables 1 and 2 provide the sample characteristics at 1998 baseline and 2008 follow-up. Construction workers were younger than the other groups, and the age difference between construction workers and all workers increased during the 10-year follow-up. Regarding racial and ethnic characteristics, construction trades had more minority workers than did white-collar occupations, but fewer than did other blue-collar workers. There were remarkable differences in the education level across the occupation groups: Only 1 of 20 construction workers had finished college (5.0%), while half (51.9%) of white-collar workers had a college education. These distributions changed slightly in the 2008 follow-up, and the proportion of low-educated workers decreased in each occupational group. Construction workers were less likely than white-collar workers to be married; this difference grew in the follow-up years. Older workers in this cohort were more likely to reside in west and south in 2008 compared with 1998, and this trend was seen across groups.

Income disparity between occupations was pronounced. The median income earned by construction worker households was only 57% of white-collar households in 1998 and 65% in 2008. In terms of average household income, the mean income appeared to rise significantly for white-collar workers, but that increase was driven by high-income outliers. The 10-year follow-up saw minimal movement in median household income (current dollar value) for any of the three occupation groups, and once we account for inflation, income has edged downward across the board.

Construction workers were dramatically less likely to have health insurance than their counterparts, particularly in the white-collar professions. More than 14% of construction workers lacked health insurance at baseline, more than twice that of white-collar workers (5.3%). Although the rate of uninsured was lower among construction workers at follow-up (since more workers were then eligible for Medicare), the disparity still existed: 8.6% of construction workers were uninsured, twice the percentage (4.2%) of other blue-collar workers, and 7 times that of white-collar workers (1.2%). In terms of coverage source, construction workers were much less likely to receive employer-provided health insurance, especially when compared with their white-collar counterparts at baseline. This disparity diminished but was still present at follow-up.

Not surprisingly, labor participation rates among the study sample were significantly reduced during aging. On average, less

**TABLE 1.** Sample Characteristics in 1998 (baseline)

	1998 Baseline			
	Construction Trades ( <i>n</i> = 510)	Other Blue-Collar Workers ( <i>n</i> = 2,886)	White-Collar Workers ( <i>n</i> = 2,501)	All Workers ( <i>n</i> = 7,200)
Mean age (year)	61.3	62.3	61.8	62.0
Age				
51–54	28.5%	21.3%	22.7%	22.9%
55–64	38.2%	40.5%	41.2%	40.2%
65+	32.7%	38.1%	36.1%	36.8%
Race				
White	88.1%	84.8%	92.6%	88.3%
Black	7.8%	11.2%	4.3%	8.1%
Other races	4.1%	4.0%	3.0%	3.6%
Hispanic origin				
Hispanic	7.8%	9.0%	2.9%	6.1%
Marriage status				
Married/partnered	81.0%	78.8%	83.4%	81.2%
Education				
High school or less	76.1%	80.0%	25.8%	54.5%
Some college	18.9%	14.6%	22.3%	19.7%
College and above	5.0%	5.4%	51.9%	25.8%
Census region				
Northeast	15.8%	14.5%	20.0%	17.4%
Midwest	24.5%	29.7%	23.1%	25.9%
South	39.4%	40.3%	35.0%	37.8%
West	20.3%	15.5%	21.8%	18.9%
Insurance coverage				
Uninsured	14.6%	8.5%	5.3%	7.8%
Insured*	85.4%	91.5%	94.7%	92.2%
Government plan	41.5%	48.8%	37.8%	43.2%
Medicare	38.4%	42.7%	35.9%	39.2%
Employer plan	44.2%	49.7%	64.9%	54.8%
Spouse's employer plan	12.8%	9.1%	11.6%	11.0%
Other health insurance plan	17.6%	16.0%	16.5%	16.6%
Long-term care insurance	7.6%	6.9%	11.8%	9.2%
Mean household income (\$)	48,683	49,352	91,378	67,984
Median household income (\$)	36,048	34,000	62,800	44,632
Labor force status				
Works full-time	42.5%	42.0%	50.3%	46.4%
Works part-time	6.1%	2.8%	2.9%	3.3%
Partly retired	8.4%	7.9%	11.3%	10.4%
Retired	35.9%	41.7%	33.1%	35.5%
Other	7.2%	5.6%	2.4%	4.3%
Weighted number (million)	1.85 (100%)	9.72 (100%)	9.45 (100%)	25.74 (100%)

\*Individuals may be insured by more than one type of plan.

than 13% of the respondents in the baseline sample still worked full-time in the 10-year follow-up. The rate of full-time workers was slightly higher in the construction cohort than the average. However, many of these full-time “construction workers” were no longer employed in construction trades at follow-up. In fact, within these full-time workers, 44% worked in nonconstruction industries, 22% changed occupations but were still in construction, and only one-third of them stayed in construction trades (4.8% of the construction baseline cohort). In addition, construction workers were more likely to work part-time or in “other” category (disabled or unemployed) at both baseline and follow-up. Moreover, construction workers had a much higher crude death rate than white-collar workers. Overall,

the construction cohort lost nearly 40% respondents (death, lost contact, or in institutions), which was lower than other blue-collar cohort, but higher than that for the white-collar cohort at the 10-year follow-up.

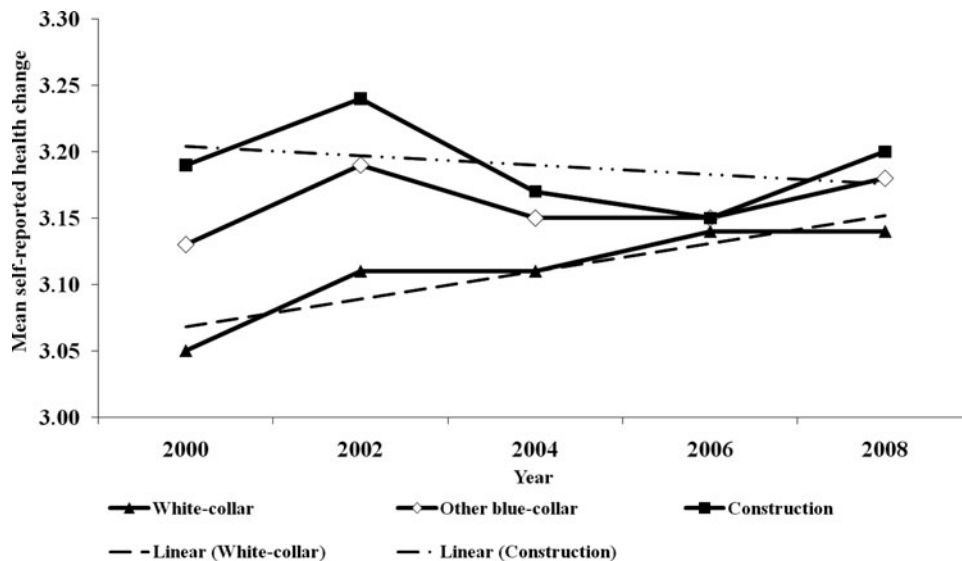
### Self-Reported Health Change

The trends in self-reported health change over follow-up survey points (2000, 2002, 2004, 2006, and 2008) are presented in Fig. 1. Over the study waves, the mean scores were consistently above 3, indicating that the change in health from the previous survey was for the worse—as would be expected with an aging population. Overall, construction workers generally had the highest mean scores, while

**TABLE 2.** Sample Characteristics in 2008 (10-Year Follow-up)

	2008 Follow-up			
	Construction Trades ( <i>n</i> = 297)	Other Blue-Collar Workers ( <i>n</i> = 1,659)	White-Collar Workers ( <i>n</i> = 1,585)	All Workers ( <i>n</i> = 4,305)
Mean age (year)	68.5	70.0	70.0	69.9
Age				
51–54	0.1%	0.0%	0.0%	0.0%
55–64	35.0%	27.8%	27.7%	28.3%
65+	64.9%	72.2%	72.3%	71.7%
Race				
White	88.4%	86.5%	93.0%	89.3%
Black	7.2%	9.8%	4.5%	7.5%
Other races	4.4%	3.7%	2.6%	3.1%
Hispanic origin				
Hispanic	7.1%	8.8%	2.3%	5.5%
Marriage status				
Married/partnered	69.7%	73.6%	78.9%	75.6%
Education				
High school or less	76.0%	79.1%	23.4%	52.0%
Some college	18.8%	15.0%	21.1%	19.5%
College and above	5.2%	6.0%	55.6%	28.6%
Census region				
Northeast	14.4%	12.9%	19.8%	16.4%
Midwest	20.8%	30.2%	22.2%	25.1%
South	41.3%	40.4%	37.0%	39.2%
West	23.5%	16.5%	20.9%	19.1%
Insurance coverage				
Uninsured	8.6%	4.2%	1.2%	3.3%
Insured*	91.4%	95.8%	98.8%	96.7%
Government plan	67.6%	76.7%	73.1%	74.2%
Medicare	64.9%	73.7%	71.6%	71.8%
Employer plan	37.5%	32.3%	45.7%	37.9%
Spouse's employer plan	9.5%	6.2%	9.2%	8.6%
Other health insurance plan	12.1%	16.9%	15.9%	16.0%
Long-term care insurance	4.6%	10.0%	20.1%	14.2%
Mean household income (\$)	53,104	48,607	148,401	92,970
Median household income (\$)	40,244	38,122	62,200	47,700
Weighted number (million) in 2008	1.50 (100%)	7.29 (100%)	7.65 (100%)	19.99 (100%)
Total sample in 1998	510	2,886	2,501	7,200
Valid respondents in 2008	61.6%	59.7%	63.9%	61.4%
Labor force status				
Works full-time	14.4%	10.3%	14.2%	12.9%
Construction	8.0%	-	-	-
Same occupation as in 1998	4.8%	6.0%	9.3%	-
Other industries	6.4%	-	-	-
Works part-time	2.2%	0.9%	1.3%	1.4%
Partly retired	7.1%	7.3%	11.6%	9.2%
Retired	36.2%	40.0%	36.4%	36.9%
Other	1.8%	1.3%	0.4%	0.9%
Invalid respondents	5.6%	4.3%	5.8%	5.1%
Died	23.6%	25.8%	19.8%	23.0%
Dropped	9.2%	10.2%	10.5%	10.5%
Weighted number (million) in 1998	1.85 (100%)	9.72 (100%)	9.45 (100%)	25.74 (100%)

\*Individuals may be insured by more than one type of plan.



**FIGURE 1.** Self-reported health change among older workers, over five waves. A score of 3 signifies no change, and scores more than 3 signify change for worse since the previous study.

white-collar workers generally had the lowest mean scores, suggesting that from survey to survey construction workers experienced a more severe decline in health status, compared with white-collar workers. However, the linear trend lines for the construction and white-collar groups show that this gap was narrowed in later years.

### Changes in Health Status, Conditions, Functional Limitations, and Health Behaviors

Table 3 shows that the prevalence of chronic diseases and functional limitations dramatically increased during the 10-year period. On average, construction workers reported having about one (1.3) doctor-diagnosed condition at baseline, but listed at least two (2.3) conditions at the 10-year follow-up. Arthritis, high blood pressure, heart problems, and diabetes ranked as the top four diagnosed diseases among construction workers at both baseline and follow-up. Despite differences in percentages, similar patterns were found among other blue-collar and white-collar workers. In all three groups, the paired *t* test results suggest significantly increased prevalence of all of the eight MD-diagnosed conditions in the surviving workers, with one exception. Psychological problems increased significantly among other worker groups, but not for construction workers. Regarding the two self-reported symptoms (back pain and memory problems) nearly 38% of older construction workers reported back problems at baseline, but unlike the other physical problems, back pain showed no difference across time in any of the three groups; while memory problems, as expected, significantly increased over time in all three groups.

Substantial difficulty with the four functional tasks was evident among this study cohort, especially difficulty in stooping/kneeling/crouching and arm extension experienced by construction workers. Health-related problems had a large effect on an individual's ability to work; nearly 31% of construction workers reported at baseline that their health problems limited their ability to work, and increased to more than 36% at follow-up. Work limitation significantly increased for all the occupational groups during the follow-up period. However, self-reported fair/poor health status and hearing problems increased significantly in groups other than construction workers.

Regarding health behaviors, smoking and heavy drinking were most common among construction workers and least observed

in white-collar workers. The percentage of respondents who were smokers went down in all three groups at follow-up; however, this change may have been largely due to death and other attrition. Mean BMI was similar across the groups, and increased most over time in the white-collar cohort. Although all three groups increased preventive health behaviors (flu shot, cholesterol test, and prostate cancer screening) over time, construction workers were least likely to engage in them both at baseline and follow-up.

### Results of Multivariate Logistic Regression Analysis

Table 4 includes the results of the multivariate logistic regression analyses. After controlling for possible confounders, the analyses revealed that construction workers were significantly more likely, both at baseline and at the 10-year follow-up, to report arthritis (odds ratio [OR] = 1.68, confidence interval [CI]: 1.37 to 2.07 at baseline; OR = 1.93, CI: 1.39 to 2.67 at follow-up) or back problems (OR = 1.46, CI: 1.14 to 1.88 at baseline; OR = 1.54, CI: 1.10 to 2.14 at follow-up), than white-collar workers. In addition, construction workers at follow-up were more likely to have CLD (OR = 1.93, CI: 1.17 to 3.20) or stroke (OR = 1.67, CI: 1.14 to 2.44) compared with the white-collar workers, although no significant differences were found at baseline. Construction workers were also significantly more likely to have work-related injuries compared with white-collar workers both at baseline (OR = 7.20, CI: 2.88 to 18.01) and at follow-up (OR = 3.12, CI: 1.10 to 8.87). However, the injury disparity between groups diminished at follow-up when job activities among construction workers were likely slowing down due to retirement or occupational changes.

A disparity in self-reported health status was also found between construction workers and white-collar workers, both at baseline and follow-up; the OR for poor/fair health status was 2.17 at baseline (CI: 1.71 to 2.75) and 1.49 at follow-up (CI: 1.12 to 1.97). With regard to the four functional limitations examined, construction workers had significantly higher odds of difficulty than white-collar workers for all four at baseline, but the differences were significant in only two of the four at follow-up (difficulty reaching or extending arms [OR = 2.18, CI: 1.40 to 3.39], and difficulty lifting or carrying 10 lb [OR = 1.67, CI: 1.03 to 2.72]). Construction workers were consistently more likely than white-collar workers to report health problems that limit their ability to work (OR 1.99, CI: 1.63 to 2.41

**TABLE 3.** Health Outcomes and Health Behaviors, Baseline vs. 10-year Follow-up

	Construction Trades			Other Blue-Collar Workers			White-Collar Workers		
	1998 Baseline (n = 510)	2008 Follow-up (n = 297)	t	1998 Baseline (n = 2,886)	2008 Follow-up (n = 1,659)	t	1998 Baseline (n = 2,501)	2008 Follow-up (n = 1,585)	t
Health conditions									
Arthritis	42.8%	66.2%	9.71**	42.1%	63.2%	23.54**	32.2%	54.1%	22.45**
High blood pressure	36.1%	60.1%	10.47**	40.6%	64.2%	24.56**	38.1%	57.7%	21.21**
Heart problems	18.4%	30.3%	6.88**	20.7%	32.9%	18.87**	18.5%	31.7%	18.72**
Diabetes	10.5%	20.9%	6.55**	13.6%	26.0%	17.63**	11.8%	22.1%	15.43**
Cancer	8.3%	17.3%	6.71**	6.7%	16.4%	14.78**	9.0%	19.9%	15.71**
Chronic lung disease	6.9%	15.2%	5.53**	7.4%	14.4%	13.72**	5.0%	8.2%	9.42**
Stroke	5.6%	13.2%	5.64**	6.0%	9.3%	10.60**	4.7%	9.2%	10.34**
Psychological Problems	8.6%	9.8%	1.08	10.3%	12.0%	5.25**	8.1%	10.4%	3.40**
Sum of eight conditions	1.3	2.3	20.78**	1.4	2.4	45.43**	1.3	2.1	42.59**
Other conditions									
Back problem	37.8%	36.3%	-0.26	33.8%	35.5%	1.43	28.4%	27.7%	-0.83
Memory problem	1.6%	4.5%	3.45**	1.8%	5.0%	8.71**	1.0%	3.8%	7.02**
Fair/poor physical health	31.4%	27.1%	1.42	32.1%	32.4%	5.71**	16.4%	19.4%	7.37**
Mental health (CESD ≥ 3)	18.2%	15.5%	-0.68	21.9%	18.2%	0.18	12.9%	11.9%	0.62
Fair/poor hearing	30.3%	29.7%	0.09	28.2%	34.7%	6.41**	16.9%	20.7%	4.83**
Functional limitations									
Stoop/kneel/crouch	33.9%	40.6%	4.28**	35.1%	46.4%	10.67**	26.6%	36.0%	10.91**
Reach/extend arms up	15.6%	17.6%	1.57	13.8%	16.3%	3.27**	8.1%	9.1%	2.15*
Push/pull large object	17.2%	15.8%	2.12*	16.1%	17.4%	5.00**	10.1%	12.5%	5.68**
Lift/carry 10lbs	11.9%	14.1%	3.38**	13.3%	15.6%	7.00**	8.4%	9.7%	4.24**
Health problem limits work	30.6%	36.3%	5.13**	29.4%	34.5%	9.77**	18.0%	23.6%	10.14**
Injury at work	14.7%	4.2%	-1.28	8.9%	6.4%	-1.61	3.0%	1.5%	-1.76
Health behaviors									
Heavy drinker (≥ 3 drinks/d)	18.1%	20.4%	-1.31	14.8%	12.2%	-4.40**	12.6%	10.8%	-2.57**
Ever smoking	76.7%	75.2%	0.00	75.1%	73.4%	2.25*	66.9%	63.4%	0.00
Current smoking	28.3%	16.2%	-4.42**	24.5%	16.0%	-9.03**	13.5%	8.0%	-6.90**
Flu shot	36.2%	61.2%	9.97**	40.0%	62.7%	19.20**	48.7%	72.1%	18.76**
Test for cholesterol	64.8%	81.7%	5.83**	67.0%	83.0%	13.17**	77.6%	90.0%	11.24**
Test for prostate	62.9%	69.2%	1.83	62.1%	70.0%	6.38**	75.6%	79.4%	3.15**
BMI	27.1	27.4	0.26	27.7	28.4	4.81**	27.2	28.0	8.45**

\*and \*\*represent significant at 5% and 1%, respectively.

at baseline; OR 2.05, CI: 1.47 to 2.87 at follow-up). And hearing ability is also more likely to be rated as fair/poor in construction workers at both time points (OR = 2.18, CI: 1.68 to 2.83 at baseline; OR = 1.74, CI: 1.23 to 2.46 at follow-up).

We did not observe significant differences in most of the health outcomes between the construction and other blue-collar workers. However, construction workers were more likely to have a stroke than other blue-collar workers, but only at follow-up (OR = 1.69, CI: 1.13 to 2.53). In addition, differences in mental health problems between worker groups were not found in this study sample, neither in psychiatric issues discussed with a doctor, nor depression symptoms as measured by the CES-D.

### DISCUSSION

This 10-year follow-up study examined health status and chronic conditions among older workers in the US construction industry. The results of this study show a sustained disparity between construction workers and their white-collar counterparts in self-reported physical health status and health changes over

time. This disparity is persistent through the study period though possibly narrowing in the most recent two surveys. This declining gap suggests that normal aging drove the steady decline in white-collar workers' health status, while construction workers' health status was somewhat more influenced by reduced construction work, for example, retirement or transition to less strenuous jobs. It has been largely accepted that self-reported health status is an informative predictor of mortality.<sup>41,42</sup> Nevertheless, further investigation is needed to determine how the perceived health status predicts medical conditions and survival rates for this older worker cohort in their later years.

This study confirms previous findings about the higher risk of CLD among construction workers.<sup>10,14</sup> The higher odds of CLD among older construction workers, despite adjustment for smoking, points to the deleterious effect of dust and chemical exposures that construction workers are more likely to endure. The odds of CLD for construction workers, compared with white-collar workers, were even higher at follow-up, which indicates the risk of CLD among construction workers estimated based on cross-sectional data could be underestimated due to the long latency of this disease.

**TABLE 4.** Adjusted Odds Ratios for Health Outcomes, Baseline Versus 10-Year Follow-up

	Adjusted OR for Health Outcomes (95% Confidence Interval)			
	Construction Trades vs. White-Collar Workers		Construction Trades vs. Other Blue-Collar Workers	
	1998 Baseline (n = 510)	2008 Follow-up (n = 297)	1998 Baseline (n = 510)	2008 Follow-up (n = 297)
<b>Health conditions</b>				
Arthritis	1.68 (1.37–2.07)**	1.93 (1.39–2.67)**	1.14 (0.91–1.44)	1.36 (0.99–1.88)
High blood pressure	0.94 (0.75–1.17)	1.17 (0.87–1.56)	0.93 (0.77–1.14)	0.98 (0.73–1.32)
Heart problems	1.04 (0.77–1.41)	1.15 (0.82–1.61)	0.93 (0.69–1.25)	1.06 (0.76–1.49)
Diabetes	0.84 (0.58–1.21)	1.01 (0.69–1.48)	0.83 (0.57–1.21)	0.64 (0.65–1.36)
Cancer	0.98 (0.69–1.40)	0.97 (0.66–1.41)	1.43 (0.92–2.22)	1.18 (0.78–1.77)
Chronic lung disease	1.21 (0.77–1.91)	1.93 (1.17–3.20)**	0.92 (0.61–1.39)	1.14 (0.73–1.77)
Stroke	1.20 (0.75–1.92)	1.67 (1.14–2.44)**	1.02 (0.64–1.64)	1.69 (1.13–2.53)**
Psychological Problems	1.05 (0.74–1.48)	0.93 (0.53–1.64)	0.85 (0.60–1.22)	0.83 (0.46–1.50)
<b>Other conditions</b>				
Back problem	1.46 (1.14–1.88)**	1.54 (1.10–2.14)**	1.16 (0.94–1.43)	1.07 (0.77–1.49)
Memory problem	1.57 (0.80–3.09)	1.25 (0.67–2.34)	0.94 (0.46–1.95)	0.99 (0.58–1.69)
Fair/poor physical health	2.17 (1.71–2.75)**	1.49 (1.12–1.97)**	1.06 (0.86–1.31)	0.89 (0.67–1.18)
Mental health (CESD $\geq$ 3)	1.14 (0.84–1.53)	1.20 (0.74–1.95)	0.81 (0.60–1.10)	0.88 (0.57–1.37)
Fair/poor hearing	2.18 (1.68–2.83)**	1.74 (1.23–2.46)**	1.14 (0.89–1.47)	0.87 (0.55–1.35)
<b>Functional limitations</b>				
Stoop/kneel/crouch	1.40 (1.13–1.75)**	1.32 (0.94–1.86)	1.02 (0.80–1.29)	0.88 (0.61–1.29)
Reach/extend arms up	1.97 (1.49–2.61)**	2.18 (1.40–3.39)**	1.16 (0.86–1.56)	1.21 (0.81–1.78)
Push/pull large object	1.73 (1.30–2.30)**	1.31 (0.79–2.19)	1.14 (0.88–1.47)	0.98 (0.62–1.54)
Lift/carry 10lb	1.36 (1.00–1.86)*	1.67 (1.03–2.72)*	0.94 (0.71–1.24)	1.06 (0.71–1.58)
Health problem limits work	1.99 (1.63–2.41)**	2.05 (1.47–2.87)**	1.15 (0.92–1.44)	1.27 (0.91–1.77)
Injury at work	7.20 (2.88–18.01)**	3.12 (1.10–8.87)*	2.11 (0.99–4.49)	0.75 (0.21–2.67)

Note: The odds ratios are adjusted by age, race, Hispanic origin, census region, marital status, BMI, heavy drinker, ever smoker, and current smoker. \* and \*\* represent significant at 5% and 1%, respectively.

Musculoskeletal diseases in aging construction workers were very common, which was consistent with previous research.<sup>14,43</sup> The cumulative toll of physically demanding construction work appears to debilitate the musculoskeletal system and limit functional abilities, most notably when workers are aging.<sup>44</sup> While this study did not explore whether such health disorders lead to early retirement, previous research shows that the decline in functional abilities and workability could pose a risk of disability retirement as well as work-related injuries for those still employed.<sup>29,45,46</sup>

Although a higher proportion of older construction workers suffered functional limitations compared with other worker groups, we observed that older construction workers were slightly more likely to work full-time than average in their later years. However, of those construction workers employed full-time at follow-up, only a third were still employed in construction trades. As pension benefits are generally less generous in the construction industry than others, a transition to jobs that are less strenuous might be one choice for those older construction workers who need a job to support themselves and their families. As suggested earlier, this occupational transition among construction workers in later life may partly explain the decreased disparity in both self-reported health status and work-related injuries between construction workers and their counterparts at follow-up.

This job transition in older construction workers raises several important issues. Because of a large number of baby boomers reaching retirement age in the next decade, a skilled labor shortage already faces many employers, including construction contractors, and is now predicted to be continuous. Thus, extending the individual's work-life and maintaining skilled and experienced workers would be one of the remedies to lessen the labor shortage, of benefit to everyone. Improvements in work environment, such as ergonomic

solutions, may help delay or prevent some early retirement due to disability.<sup>47,48</sup> Worksite safety and health programs should address concerns of older workers, such as functional limitations or deficits due to age, and integrate them in ongoing safety assessment and solutions. Since contingent and part-time jobs are common in aging workers, worksite interventions should also take nontraditional employment into consideration.<sup>49,50</sup> Given that a great number of older construction workers change occupations in later life, job training should be available for older workers as well as younger ones. Moreover, pension security should also be recognized as a critical element in supporting aging workers. Currently the age for social security retirement eligibility is being raised incrementally,<sup>51</sup> and there are some suggestions for further raising retirement age.<sup>52</sup> However, the more severe, debilitating conditions borne by construction workers are cause for advocating an allowance for earlier retirement in certain more strenuous and high-risk occupations.<sup>53–55</sup> Further study of early retirement in the construction workforce—its health-related causes and its effects on financial well-being—would provide insight for policymakers and workers.

Although it is known that hypertension and heart problems are key risk factors for stroke, this study did not show increased cardiovascular problems diagnosed among construction workers—despite higher levels of smoking and moderately heavy drinking. This made it complex to interpret the higher risk of stroke in construction workers observed in their later years. Research has found that lack of regular medical care and of health insurance result in underdiagnosis of health problems.<sup>56–59</sup> It is more likely that chronic conditions such as hypertension and heart problems would go underdiagnosed than a stroke, which requires tertiary-care intervention. Given what we observed in this study (see Tables 1 and 2), it would be rational to assume that the higher risk of stroke among older

construction workers was a result of lower health insurance coverage and less preventive care. Furthermore, while this study was not able to find a higher risk regarding hypertension in the construction cohort, recent research using the same data source by Leigh and Du found a higher prevalence of hypertension among construction workers aged 65 years and older, an older subset than our cohort.<sup>60</sup> Given this age difference between the study cohorts, the diverse findings suggest the possibility of delayed reporting of hypertension among construction workers. Further research should be conducted to confirm the findings and study risk factors of stroke more broadly.

While the longitudinal approach of this study improves our ability to estimate health outcomes based on occupation history across worker's later life, the narrowed disparity in several conditions in the most recent waves, may also reflect a "healthy worker/survivor effect."<sup>61</sup> The higher rates of death or institutionalization in the construction worker cohort could explain some of the disparity reduction between construction workers and white-collar counterparts at follow-up, since sicker, less healthy respondents may be more likely to have died or in reside in institutions. Earlier studies that examined subjects lost to death and other types of attrition note that mortality during the study period was likelier among racial minorities, those with less education, smokers, and persons reporting worse overall health and functional abilities.<sup>62,63</sup> Similar results were observed in this study: the proportion of low-educated and racial minority workers was somewhat reduced at follow-up (Tables 1 and 2). However, further stratified studies on causes of death and lost cases would be needed for a clear answer.

## CONCLUSION

The findings indicate that construction workers are more likely than white-collar workers to experience chronic diseases and functional limitations over the aging process; at the same time, there is a persistent disparity in self-reported health status between construction and white-collar workers. The results, which were adjusted for demographic characteristics, smoking, heavy drinking, and BMI, suggest that working primarily in construction trades may exacerbate the usual decline in overall health status and workability and increase the likelihood of functional limitations, the odds of arthritis, back problems, CLD, and stroke in later years. Indeed, the gap in these problems between construction and white-collar workers actually increases over time. Furthermore, in contrast to white-collar workers, construction workers have higher likelihood of work-related injuries and hearing problems at both baseline and follow-up. Finally, although older construction workers were slightly more likely to work full-time than average in their later years, two-thirds of the construction worker cohort were not employed in construction trades any more in the follow-up.

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