Original article

Participation in a US community-based cardiovascular health study: investigating nonrandom selection effects related to employment, perceived stress, work-related stress, and family caregiving

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ARTICLE INFO

ABSTRACT

Purpose: Participation in health studies may be inversely associated with employment and stress. We investigated whether employment, perceived stress, work-related stress, and family caregiving were related to participation in a longitudinal US community-based health study of black and white men and women aged ≥45 years.
Methods: Prevalence ratios and confidence intervals were estimated for completion of the second stage (S2) of a two-stage enrollment process by employment (status, type), and stress (perceived stress, work-related stress, caregiving), adjusting for age, sex, race, region, income, and education. Eligibility and consent for a follow-up occupational survey were similarly evaluated.
Results: Wage- but not self-employed participants were less likely than the unemployed to complete S2. Among the employed, S2 completion did not vary by stress; however, family caregivers with a short time burden of care (<2 hour/d) were more likely to complete S2, compared to noncaregivers. Eligibility and participation in the follow-up occupational survey were higher among those employed (vs. unemployed) at enrollment but were not associated with enrollment stress levels.
Conclusions: Limited evidence of selection bias was seen by employment and stress within a large US community-based cohort, but findings suggest the need for enrollment procedures to consider possible barriers to participation among wage-employed individuals.

Published by Elsevier Inc.

Introduction

Occupation is a major social determinant of adult health [1,2], a source of social and environmental exposures, a marker of socioeconomic position, and an important aspect of community life [3–5]. Given the important role occupation plays in community health, it is important for community-based epidemiologic studies to collect data on employment status and job characteristics [4,6].

However, few studies have examined empirically the challenges in recruiting employed individuals and collecting high-quality occupational data in a community setting, an increasingly important issue since response rates appear to be declining [7,8].

Epidemiologic studies can be subjected to selection bias if study participation or follow-up is incomplete and "selection probabilities are related both to exposure and health outcome [9]." Study participation may be influenced by socioeconomic status (SES), employment status, and working conditions. For example, a European study reported lower participation in a follow-up health examination survey among lower SES participants, unemployed, or unskilled laborers, those working longer hours, and those in poor health [10]. Another European study found significantly lower rates of follow-up among those employed full time, compared to those without paid work [11]. Two studies reported lower survey responses at follow-up

among those with higher exposure to some work-related stressors (i.e., overload and job strain) but not others (i.e., role ambiguity and role conflict) [12,13]. In one of these studies, the association of SES and survey response was mediated by job strain [13].

In longitudinal studies, nonparticipation can occur at both recruitment and follow-up. For example, an individual may agree to participate in a study but then fail to follow through and complete all aspects of data collection, especially if it is conducted over multiple days. Other participants may not continue to participate at follow-up several years after study enrollment. Our objective was to examine participation in a large US community-based longitudinal study at two time points: at the second stage of two-stage enrollment process and at follow-up several years later. We hypothesized a priori that those less likely to complete enrollment would be employed, have family caregiving responsibilities, and experience higher stress (perceived stress, work-related stress, and family caregiver stress). We also hypothesized that employed individuals with any measured source of stress would be disproportionately underrepresented at follow-up.

Methods

Study design, settings, and participants

The REasons for Geographic And Racial Differences in Stroke (REGARDS) study is a US national community-based longitudinal study of 30,239 black and white men and women aged ≥45 years [14]. Designed to investigate causes of regional and racial disparities in stroke, the study oversampled blacks and residents of the stroke belt and buckle, areas in the southeastern United States characterized by high stroke mortality [15,16]. The study was designed with a recruitment goal of 30,000 adults balanced on sex and race, with 30% from the stroke belt, 20% from the stroke buckle, and the remainder from elsewhere in the continental United States. Eligible adults had a name, telephone number, and address in a commercially available nationwide list of US households routinely updated from multiple sources (e.g., telephone directories, motor vehicle registrations, real estate listings, driver's license data), with an estimated coverage of 95% of community-dwelling US citizens [17]. Approximately 2 weeks prior to telephone contact, prospective participants were mailed a letter and brochure introducing the study. Further details about the study design and characteristics of the REGARDS cohort can be found elsewhere [14,18].

The study involved a two-stage enrollment process (Fig. 1). In stage 1 (S1), individuals provided verbal informed consent and completed a computer-assisted telephone interview (CATI). In stage 2 (S2), individuals completed an in-home clinical examination, provided written informed consent, and became eligible for follow-up. As reported previously, "the telephone response rate, defined according to American Association for Public Opinion Research standards, was 33% and cooperation rate was 49%" [18,19]. Seventy percent of the proportion eligible and enrolled in stage 1 completed stage 2.

Clinical examinations, which took 60−90 minutes to complete, included measures of height, weight, blood pressure, resting electrocardiogram, and phlebotomy and urine collection using a standard protocol [14]. Examinations were conducted on weekday mornings so biological specimens could be processed for afternoon shipment to a central laboratory. Participants who completed both
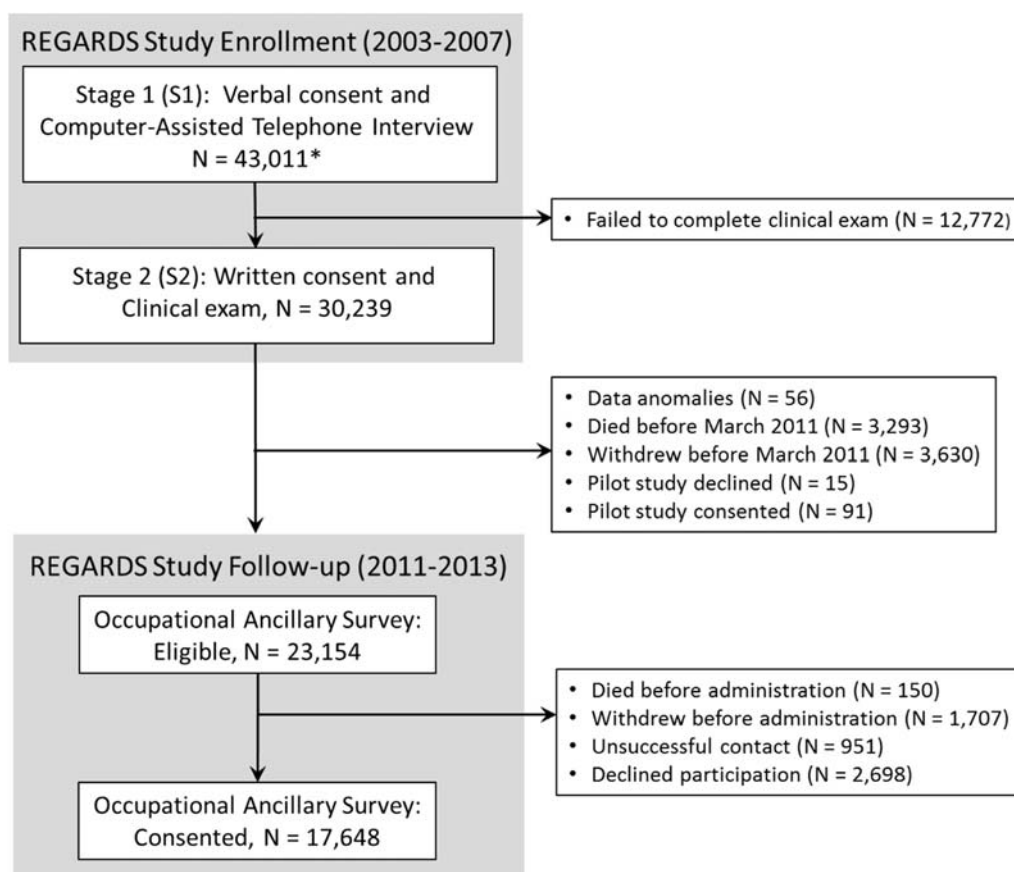
Fig. 1. Sample size tracing for REGARDS Enrollment Stages 1 and 2 and follow-up. *Of 43,011, employment status was known for only 26,730 (9863 of these were employed) because employment status was not available for participants who enrolled before this variable was added to the computer-assisted telephone interview in about July 2004.

Table 1
Predictors of S2 "complete" status among all who verbally consented to the S1 CATI (n = 43,011) and further limited to those known to be employed at S1 (n = 9863)[*]

S1 enrollment characteristic	S1 full sample (n = 43,011)			S1 employed sample (n = 9863)		
	No.	% complete	P-value[†]	No.	% complete	P-value
Age at enrollment (y)[‡]						
45–54	5635	67.2	<.001	3557	66.6	<.001
55–64	16,213	71.2	—	4514	70.8	—
65–74	13,291	72.9	—	1473	71.9	—
75+	7872	65.7	—	319	73.7	—
Sex						
Female	24,422	68.1	<.001	6202	68.3	<.001
Male	18,589	72.9	—	3661	71.7	—
Race						
Black	20,091	62.3	<.001	4274	61.7	<.001
White	22,920	77.1	—	5589	75.6	—
Region[§]						
Stroke buckle	8658	72.8	<.001	2441	71.0	.002
Other stroke belt	15,083	69.3	—	3562	67.4	—
Other contiguous United States	19,238	69.8	—	3855	70.8	—
Income						
Refused	6084	61.3	<.001	959	62.3	<.001
<$20,000	8448	64.8	—	832	62.9	—
$20,000–<$35,000	10,336	70.7	—	1873	66.0	—
$35,000–<$75,000	11,988	74.4	—	3540	70.3	—
$75,000+	6155	77.2	—	2659	75.8	—
Education						
Less than high school	6590	57.5	<.001	677	55.4	<.001
High school	11,541	67.6	—	2263	65.1	—
Some college	11,189	72.3	—	2871	69.9	—
College graduate and higher	13,639	76.8	—	4050	74.2	—
Perceived stress						
None	12,406	70.9	<.001	2364	69.5	.006
Low	11,651	72.9	—	2897	71.8	—
Moderate	9555	70.5	—	2555	69.0	—
High	8699	66.3	—	1942	67.2	—
Family caregiver status						
No	37,802	70.0	.004	8640	69.4	.41
Yes	5157	71.9	—	1218	70.6	—
Caregiving time burden[‖]						
<2 hours/d	2240	75.4	<.001	608	75.3	<.001
≥2 hours/d	2288	69.6	—	500	65.2	—
Caregiving strain						
None	1714	72.3	.034	356	70.2	.95
Some strain	2508	73.1	—	639	71.0	—
A lot of strain	910	68.6	—	218	70.2	—
Employment status availability[¶]						
Not available	16,281	70.0	.47	—	—	—
Available	26,730	70.3	—	—	—	—
Employment status						
Not employed	16,867	70.7	.044	—	—	—
Employed	9863	69.9	—	—	—	—
Type of employment						
Wage employed	—	—	—	7623	67.2	<.001
Self-employed	—	—	—	2240	77.5	—
Work-related stress						
Think about work						
No	—	—	—	4911	67.4	<.001
Yes	—	—	—	4878	71.8	—
Stretched to the very limits by work						
No	—	—	—	6041	69.4	.47
Yes	—	—	—	3736	70.1	—
Dissatisfied with daily work activity						
No	—	—	—	7019	69.4	.34
Yes	—	—	—	2710	70.4	—
Number of job stressors						
0	—	—	—	3287	67.4	<.001
1–3	—	—	—	6455	70.8	—

[*] All verbal consenters completed the enrollment CATI (S1); "complete" enrollees scheduled and subsequently completed a clinical examination (S2).

[†] P-value based on the likelihood ratio test of the bivariate association between participation and each enrollment characteristic (not adjusted for any other factors), excluding participants with unknown region (n = 32), education (n = 52), perceived stress (n = 700), family caregiver status (n = 52), caregiver hours (n = 629), caregiver strain (n = 25), or job stressors (n = 74–134, among the employed).

[‡] At inception of the study, age of 50 years or older was the threshold for participation in the study, but this threshold was lowered to 45 years in April 2004.

[§] The stroke belt included the states of North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee, Arkansas, and Louisiana; the stroke buckle consisted of 153 counties along the eastern seaboard of North Carolina, South Carolina, and Georgia.

[‖] Two hours/d was the approximate median number of hours reported among those providing care. Those with more than 2 hours/d on average include n = 396 that reported 24-7 care (i.e., 24 hours/d × 7 days/wk = 168 hours/wk) and a small number (n = 17) who reported more than 168 hours/wk.

[¶] Due to a lag in the collection of employment status (added to the enrollment CATI about July 2004), this variable was available at S1 for 26,730 of the full sample.

Table 2
Prevalence ratios for S2 enrollment completion according to the sociodemographic variables and employment type among those with known employment status ($n = 26{,}686$) and those employed at enrollment ($n = 9856$)

S1 enrollment characteristic	S1 Employment status known*				S1 employed†			
	Bivariate models		Multivariable model		Bivariate models		Multivariable model	
	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Age at enrollment (y)								
45—54 (referent)	1.00	—	1.00	—	1.00	—	1.00	—
55—64	1.07	1.05—1.10	1.06	1.04—1.08	1.06	1.03—1.10	1.06	1.03—1.09
65—74	1.08	1.06—1.11	1.08	1.05—1.10	1.08	1.04—1.12	1.08	1.04—1.12
75+	0.97	0.94—0.99	0.97	0.94—1.00	1.11	1.03—1.19	1.09	1.02—1.16
Sex								
Female (referent)	1.00	—	1.00	—	1.00	—	1.00	—
Male	1.06	1.04—1.08	1.03	1.02—1.05	1.05	1.02—1.08	1.01	0.98—1.03
Race								
Black (referent)	1.00	—	1.00	—	1.00	—	1.00	—
White	1.23	1.21—1.25	1.17	1.15—1.19	1.22	1.19—1.26	1.16	1.13—1.20
Region								
Stroke buckle	1.06	1.04—1.08	1.04	1.02—1.06	1.05	1.02—1.09	1.03	0.99—1.06
Other stroke belt (referent)	1.00	—	1.00	—	1.00	—	1.00	—
Other contiguous United States	1.02	1.00—1.04	1.00	0.98—1.02	1.05	1.02—1.08	1.01	0.98—1.04
Income								
Refused	0.98	0.95—1.01	0.95	0.92—0.98	0.99	0.92—1.06	0.92	0.86—0.99
<$20,000 (referent)	1.00	—	1.00	—	1.00	—	1.00	—
$20,000—<$35,000	1.09	1.06—1.12	1.03	1.00—1.06	1.05	0.99—1.12	1.00	0.94—1.06
$35,000—<$75,000	1.16	1.13—1.19	1.06	1.03—1.08	1.12	1.06—1.18	1.03	0.97—1.09
$75,000+	1.22	1.18—1.25	1.08	1.05—1.11	1.20	1.14—1.27	1.06	1.00—1.12
Education								
Less than high school (referent)	1.00	—	1.00	—	1.00	—	1.00	—
High school	1.19	1.15—1.22	1.13	1.09—1.17	1.18	1.09—1.27	1.13	1.05—1.21
Some college	1.27	1.23—1.31	1.20	1.16—1.23	1.26	1.18—1.36	1.19	1.11—1.27
College graduate and higher	1.34	1.30—1.38	1.23	1.20—1.27	1.34	1.25—1.44	1.23	1.14—1.32
Employment status								
Not employed‡	1.00	—	1.00	—	—	—	—	—
Wage employed§	0.95	0.93—0.97	0.90	0.89—0.92	1.00	—	1.00	—
Self-employed	1.09	1.07—1.12	1.00	0.98—1.03	1.15	1.12—1.18	1.11	1.08—1.14

CI = confidence interval.

* Log-binomial regression models included 26,686 participants with known employment status (26,730 participants with known employment status at S1 CATI less 22 participants with unknown region and 22 participants with unknown education). Seven bivariate models evaluated one variable at a time; one multivariable model evaluated all seven variables simultaneously.

† Log-binomial regression models generally included 9856 employed participants (9863 employed participants less five participants with unknown region and two participants with unknown education). Seven bivariate models evaluated one variable at a time; one multivariable model evaluated all seven variables simultaneously.

‡ Referent category for regression models of S1 participants with known employment status.

§ Referent category for regression models of S1 participants employed at enrollment.

stages of enrollment, that is, "complete participants," were provided $30 as compensation for their time and received a copy of their examination results; complete participants are followed biannually by CATI to identify hospitalizations and major health events.

S1 enrollment CATI

During enrollment (2003—2007), the following data were collected by CATI: demographics, household income, education, health behaviors, medical history, depressive symptoms, perceived stress, and social environment information (social support, social network, and caregiving activities) [14]. Perceived stress was measured using a modified version of Cohen's perceived stress scale: "in the last month how often have you" (1) "felt that you were unable to control the important things in your life," (2) "felt confident about your ability to handle your personal problems" (reverse scored), (3) "found that you could not cope with all the things that you had to do," and (4) "felt difficulties were piling up so high that you could not overcome them." Items were scored on a 5-point scale (0—4: "never," "almost never," "sometimes," "fairly often," and "very often"). Cronbach's alpha increased from 0.65 to 0.74 after omitting item (2), yielding a 3-item scale. Perceived stress was derived by summation, with classification based on approximate quartiles: highly (sum >4), moderately (3—4), low (1—2), and not (0) stressed [20].

Caregiving demands were assessed using items adapted from a study of spousal caregivers: "are you currently providing care on an ongoing basis to a family member with a chronic illness or disability," and if yes, "how many hours per week do you spend providing care to this person," and "how much of a mental or emotional strain is it on you to provide this care (none, some, or a lot)." Time burden of care was dichotomized at 2 hours/d (approximate median) [21].

During the second year of recruitment, the CATI was expanded to include employment status: employed for wages, self-employed, out of work >1 year, out of work <1 year, homemaker, student, retired, or unable to work. Additionally, employed participants were asked three items from the 10-item Framingham Type A Scale [22], which were treated as proxy measures of work-related stress: (1) "has your work often stayed with you so that you were thinking about work after working hours, or all day long," (2) "has your work or daily work activity often stretched you to the very limits of your energy and capacity," and (3) "have you often felt uncertain, uncomfortable or dissatisfied with how well you were doing in your regular line of work or daily work activity." Dichotomous responses ("yes" or "no") were reported. Because internal reliability was low (Cronbach's alpha 0.56), these items were analyzed separately and combined (0 vs. 1—3 items).

Table 3
Prevalence ratios for S2 enrollment completion by type of stress among employed participants[*]

S1 enrollment characteristic	Crude[†]		Adjusted[‡]	
	PR	95% CI	PR	95% CI
Perceived stress				
None (referent)	1.00	—	1.00	—
Low	1.03	1.00–1.07	1.01	0.98–1.05
Moderate	0.99	0.96–1.03	0.99	0.95–1.02
High	0.97	0.93–1.01	0.99	0.95–1.03
Caregiver status/time burden				
No care (referent)	1.00	—	1.00	—
Yes, <2 hours/d	**1.08**	**1.03–1.14**	**1.07**	**1.02–1.12**
Yes, ≥2 hours/d	0.94	0.88–1.00	0.97	0.91–1.03
Caregiver status/strain				
No care (referent)	1.00	—	1.00	—
Yes, no strain	1.01	0.94–1.08	1.06	1.00–1.12
Yes, some strain	1.02	0.97–1.08	1.03	0.98–1.08
Yes, a lot of strain	1.01	0.93–1.10	0.99	0.90–1.08
Work-related stress				
Think about work				
No (referent)	1.00	—	1.00	—
Yes	**1.07**	**1.04–1.09**	1.02	0.99–1.05
Stretched to very limits by work				
No (referent)	1.00	—	1.00	—
Yes	1.01	0.98–1.04	1.00	0.97–1.02
Dissatisfied with daily work activity				
No (referent)	1.00	—	1.00	—
Yes	1.01	0.99–1.04	1.02	0.99–1.05
Number of job stressors				
0 (referent)	1.00	—	1.00	—
1–3	**1.05**	**1.02–1.08**	1.01	0.98–1.04

CI = confidence interval.

[*] Log-binomial regression models generally included 9856 employed participants (9863 employed participants less five participants with unknown region and two participants with unknown education). Models evaluating global perceived stress excluded 105 participants with an unknown value; caregiver status/time excluded 115 participants with an unknown value; caregiver status/strain excluded 10 participants with an unknown value; and the job stressors excluded 10, 88, 74, 86, and 134 participants with unknown values, respectively.

[†] Prevalence ratios are unadjusted. Results in bold-face are statistically significant at a 5% level of significance.

[‡] Prevalence ratios are adjusted for age at enrollment, sex, race, region, income, and education.

Follow-up occupational ancillary study

During routine follow-up (2011–2013), all active REGARDS study participants were invited to complete an occupational survey administered by CATI a median of 6.5 years after enrollment, with 87% consenting (Fig. 1) [23]. The survey collected work history (job held at enrollment, longest held job) and current job information: industry and occupation, and job characteristics.

Statistical analysis

Among those who completed the first stage of enrollment (i.e., enrollment CATI), the likelihood ratio χ^2 test was used to compare completion of the second stage of enrollment (i.e., clinical examination) by age, sex, race, region, household income, education, perceived stress, family caregiver status, and employment status (and its availability, due to delayed collection). Similar analyses were performed to compare S2 completion among those employed. This also included an assessment of employment type (wage and self-employed) and work-related stress. Among participants who completed S2, analysis of variance was used to compare the mean number of days necessary to schedule and conduct the clinical examination (S2) by employment status and type.

Prevalence ratios (PRs) for S2 completion by age, sex, race, region, income, education, and employment status were estimated from log-binomial regression models using robust variance estimation to account for potential model misspecification [24]. Similar analyses were performed to estimate PRs for S2 completion among employed participants, including employment type and the stress variables. Among participants who completed S2, similar methods were used to examine eligibility and consent to complete the follow-up occupational survey.

Statistical analyses were performed using SAS Software (version 9.3, SAS Institute Inc., Cary, NC). Analyses excluded participants with unknown values, except for those missing income for which a separate category for missing values was used.

Results

Completion of S2 enrollment (clinical examination)

Among the full S1 sample ($n = 43,011$), S2 completion was associated with all sociodemographic and stress variables evaluated (Table 1). Completion was higher for males, whites, and participants living within versus outside the stroke buckle. Completion increased with higher income, education, and age (<75 years); completion decreased with perceived stress. Completion was higher for family caregivers compared to noncaregivers; however, caregivers' completion was lower when caregiving was required ≥2 hours/d or was associated with mental or emotional strain.

Among 9863 participants employed at S1, similar results were found for sex, race, income, education, and perceived stress (Table 1); however, completion more clearly increased with age and was higher for the stroke buckle and other areas of the continental United States, compared to the stroke belt. S2 completion among the employed was not associated with caregiving status/strain but was once again lower when care was required ≥2 hours/d. Completion was higher for self-employed (77.5%) compared to wage-employed (67.2%) participants and among employed participants "thinking about work after work hours." Completion status did not differ for those feeling "stretched to the very limits by work" or "dissatisfied with daily work activity."

In multivariable models (Table 2), PRs for S2 completion were attenuated for associations with age, sex, race, region, income, and education, compared with bivariate results. Compared to unemployed participants, wage employed but not self-employed participants had lower completion. On average, unemployed participants completed S2 in less time (39 days), compared with self-employed participants (mean 4 additional days) and wage employed (mean 7 additional days). Among the employed, self-employed participants were 11% more likely to complete S2 of enrollment, compared to wage employed.

Associations between stress and S2 completion among employed participants are shown in Table 3. Completion did not vary by perceived stress or work-related stress; however, completion was higher among family caregivers who were employed and providing <2 hours/d of care.

Eligibility and consent to the occupational survey

Those employed at enrollment were more likely than the unemployed to still be an active study participant (i.e., alive and participating) and thus eligible to participate in the occupational survey at follow-up (Table 4). Among those employed at S1, eligibility and consent at follow-up were not associated with any S1 stress; additionally, wage-employed participants were slightly more likely to consent to the occupational survey, compared with unemployed and self-employed individuals.

Table 4
Prevalence ratios for eligibility and consent for the follow-up (FU) occupational survey by employment status and stress

S1 characteristic	Follow-up Eligible[*]				Follow-up Consented[†]			
	Crude[‡]		Adjusted[§]		Crude[‡]		Adjusted[§]	
	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Among 23,730 with S1 employment status								
Not employed (referent)	1.00	—	1.00	—	1.00	—	1.00	—
Wage employed	**1.13**	**1.11–1.14**	**1.05**	**1.03–1.06**	**1.06**	**1.05–1.08**	**1.03**	**1.01–1.05**
Self-employed	**1.11**	**1.09–1.14**	**1.05**	**1.03–1.07**	**1.04**	**1.01–1.07**	1.00	0.97–1.03
Among 9863 employed at stage 1								
Perceived stress								
None, low, moderate (referent)	1.00	—	1.00	—	1.00	—	1.00	—
High	0.99	0.97–1.01	1.00	0.97–1.02	0.96	0.93–1.00	0.98	0.94–1.01
Caregiver status/time burden								
No care (referent)	1.00	—	1.00	—	1.00	—	1.00	—
Yes, <2 hours/day	**1.05**	**1.02–1.08**	1.02	1.00–1.05	1.02	0.98–1.07	1.00	0.96–1.05
Yes, ≥2 hours/day	1.00	0.96–1.04	1.01	0.97–1.05	0.95	0.89–1.02	0.97	0.91–1.03
Caregiver status/strain								
No care (referent)	1.00	—	1.00	—	1.00	—	1.00	—
Yes, no strain	1.03	0.99–1.07	1.04	1.03–1.06	0.99	0.92–1.06	1.00	0.93–1.06
Yes, some strain	1.02	0.99–1.05	1.01	0.98–1.04	0.98	0.93–1.03	0.98	0.93–1.03
Yes, a lot of strain	0.98	0.91–1.04	0.97	0.91–1.03	1.00	0.92–1.09	1.00	0.93–1.09
Work-related stress								
Think about work								
No (referent)	1.00	—	1.00	—	1.00	—	1.00	—
Yes	**1.03**	**1.01–1.05**	1.01	0.99–1.02	1.03	1.00–1.06	1.01	0.98–1.03
Stretched to very limits by work								
No (referent)	1.00	—	1.00	—	1.00	—	1.00	—
Yes	1.02	1.00–1.04	1.01	0.99–1.03	0.98	0.96–1.01	0.98	0.96–1.00
Dissatisfied with daily work activity								
No (referent)	1.00	—	1.00	—	1.00	—	1.00	—
Yes	1.01	0.99–1.03	1.00	0.99–1.02	**0.96**	**0.93–0.98**	0.97	0.94–1.00
Number of job stressors								
0 (referent)	1.00	—	1.00	—	1.00	—	1.00	—
1–3	1.03	1.00–1.05	1.01	0.99–1.04	1.00	0.97–1.03	0.99	0.97–1.02

CI = confidence interval.

[*] Eligible participants included all active study participants at the inception of administration of the occupational survey (March 2011).

[†] Eligible participants who consented to the occupational survey during a 2-year administration period (March 2011 to March 2013). Eligible participants who died or withdrew before the occupational supplement could be administered or who were otherwise not contacted despite repeated call attempts could not be consented (n = 2808).

[‡] Prevalence ratios are unadjusted. Results in bold face are statistically significant at a 5% level of significance.

[§] Prevalence ratios are adjusted for age at S1, sex, race, region, income, and education.

Discussion

The magnitude and direction of nonparticipation bias was investigated in a large national longitudinal community-based cohort of adults aged ≥45 years. We examined employment status and type (wage vs. self-employed), perceived stress, work-related stress, and family caregiving as potential determinants of participation at stage 2 of a two-stage enrollment process and at follow-up when an occupational survey was administered. The hypothesis that enrollment completion would be lower among employed individuals was partially supported; wage but not self-employed individuals were 10% less likely to complete the S2 clinical examination, compared to the unemployed. In contrast to expectation, wage-employed participants were more likely to be eligible for the follow-up survey (compared with unemployed) and to consent (compared with unemployed and self-employed). So while wage-employed individuals were less likely to complete enrollment, those who did were more likely to remain active in the study and consent to an optional 10-minute occupational module during routine follow-up.

It appears that this is the first study to identify differences in participation by type of paid employment. Wage-employed individuals may face more practical barriers to participation in community-based health research than self-employed individuals due to schedule constraints. This interpretation is consistent with the following observation by investigators of the Coronary Artery Risk Development in Young Adults Study: "it was particularly challenging to recruit enough persons with a high school education or less because they were relatively infrequent in the population and often found it difficult to arrange time off from their blue-collar jobs" [25]. Similarly, enrollment completion was inversely associated with education in the Atherosclerosis Risk in Communities Study [26], which may be partly explained by unmeasured differences in employment-related barriers.

Within the REGARDS study, reasons for delays in scheduling examinations were not collected, so we could not directly examine the potential for work schedules to impede S2 completion; however, we found that wage-employed individuals required more time to complete the examination, compared to both self-employed (4 additional days) and unemployed (7 additional days) individuals. These results are congruent with prior research suggesting that late responders exhibit characteristics of nonresponders [27] and highlight the importance of repeat scheduling efforts to mitigate differentials in participation by employment type. Wage employment may additionally inhibit study participation if these individuals experience greater physical workload, low job control, and chemical exposures [28,29]. Additionally, work overload was associated with nonresponse in one study due to "cognitive and information-processing loads required in survey completion" [12].

Additional evidence that work schedule flexibility may influence participation among employed individuals includes the finding that self-employed individuals were more likely than wage employed to complete enrollment. Nearly one quarter of REGARDS participants were self-employed at enrollment, versus 15% of workers in the US labor market, after age and sex adjustment (Appendix A).

Self-employment among the older REGARDS cohort may be indicative of bridge employment—that is, the span between a career job and full retirement [30], which has been found to be associated with greater job control and schedule flexibility [31]. Because there may be qualitatively different job characteristics associated with self-employment for individuals age <45 years, our findings may not generalize to younger self-employed individuals. While slight over-representation of self-employed individuals in REGARDS improves that opportunity to examine this understudied segment of the labor force, knowledge that participation in the study varied by employment type will aid interpretation and future decisions about statistical adjustment to account for differential participation [27,32].

This investigation follows a previous report identifying longitudinal community-based cohort studies as a potential means to study vulnerable and hard-to-reach workers [4, 33] and established the feasibility of supplementing the REGARDS study cohort with occupational data [23]. While the magnitude of nonresponse bias appears limited within the REGARDS cohort, it is important to note that general population samples may exhibit greater nonresponse than population-specific samples (e.g., industrial or worksite specific) [34]. Because prior investigations of nonparticipation among employed samples have been performed primarily within organizational research studies [12], our findings address an important gap within the broader public health literature; the findings additionally highlight the need for community-based health researchers to consider and accommodate employment-related barriers to study participation and to effectively communicate the benefits of participation within the most economically active segment of the population [35,36]. It is noteworthy, however, that mounting evidence suggests that participation rates and nonresponse biases often do not substantially impact exposure-response investigations [37], including investigations examining associations between occupational class and health [38].

The hypotheses that enrollment completion would be lower among those with high perceived stress or high work-related stress were not supported after adjustment. Moreover, employed family caregivers providing <2 hours/d of care were more likely than employed noncaregivers to complete enrollment, which is inconsistent with evidence from one study suggesting that employed caregivers experience role overload, making it difficult for them to participate in health studies [39]. Several factors may explain this incongruence: first, higher participation was only identified among employed caregivers with less than 2 hours of daily caregiving, so role overload may not have been triggered; second, caregivers may be more likely to participate in health studies due to topic salience [40]. Neither high stress nor family caregiving responsibilities were predictive of reduced eligibility or consent at follow-up.

Our study has several strengths and limitations. The large sample size allowed us to evaluate multivariable models; however, these may have produced statistically significant differences when absolute differences were small. Because data were not collected on participants who declined at initial contact (S1), our investigation of the determinants of nonresponse is limited to those who consented at S1. Although analyses used robust variance estimation, the possibility of measurement error remains due to the two-stage sampling design [41]. Employment status was missing for some enrollees; however, because completion did not vary according to employment status, these missing data did not impact our results. We could not directly examine whether completion varied by job characteristics because occupational data were not collected at S1. Finally, while we considered several measures of stress, some had modest reliability in our sample. We used proxy measures of job stress based on three items from the Framingham Type A Scale designed to measure the type A personality trait. These items were used in our analysis to represent stress stemming from the spillover of work into nonwork life, excessive work demands, and work dissatisfaction; however, their use complicates comparisons of our results to other studies of job stress and study participation where standard measures of job stressors were used.

Conclusion

This study examined empirically the magnitude and direction of several employment and stress-related determinants of nonresponse in a national longitudinal community-based health study of adults aged ≥45 years. Despite the broad scope of our inquiry and adequate statistical power, we did not observe strong selection effects. Enrollment completion was slightly lower among wage employed and slightly higher among self-employed individuals and employed caregivers with time-limited caregiving demands. Wage-employed individuals were slightly more likely to participate in an optional occupation survey at follow-up. While response biases due to these factors in the REGARDS cohort are expected to be small, the findings highlight the need to identify employment-related barriers to study participation by wage-employed individuals who may require greater schedule accommodations.

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Appendix A

The purpose of this analysis was to compare the fraction of REGARDS participants who were self-employed at enrollment to the fraction of the US population who were self-employed at enrollment.

For REGARDS stage 1, of 26,730 with known employment status, 16,867 were not employed and 9863 were employed: 7623 wage and 2240 self. Thus 2240/9863 = 22.7% of those employed at stage 1 were self-employed.

For the US population, we used estimates provided by the US Bureau of Labor Statistics. To account for differences between the REGARDS sample and the US population, we considered two methods of estimating the fraction who were self-employed. The first method used age-specific estimates from 2005 (the midpoint of the duration of data collection) and adjusted for age. Because sex- and age-specific estimates are not available in 2005, the second method adjusted for sex and age using the average of sex- and age-specific estimates from 2003 to 2009.

Method 1: Compare to the US population, adjusting for age

Table A1
For REGARDS stage 1, the distribution of age, among the employed

Age category	Count
45–54	3557
55–64	4514
65+	1473 + 319 = 1792

Table A2
Percent self-employed for these age categories in the United States in 2005

Age category	Percent self-employed*		
	Unincorporated	Incorporated	Total
45–54	7.9	4.9	12.8
55–64	10.3	5.9	16.2
65+	15.9	8.5	24.4

* Source: http://www.bls.gov/opub/mlr/2010/09/art2full.pdf (date last accessed 15 March 2017).

Equation A1. Percent self-employed in the United States in 2005, age standardized to the REGARDS stage 1 sample:

$$\frac{3557 \times 12.8\% + 4514 \times 16.2\% + 1792 \times 24.4\%}{3557 + 4514 + 1792} = 16.5\%$$

Method 2: Compare to the US population, adjusting for age and sex

Table A3
For REGARDS stage 1, the distribution of age and sex, among the employed

Age category	Count	
	Male	Female
45–54	1336	2221
55–64	1586	2928
65+	589 + 150 = 739	884 + 169 = 1053

Table A4
Percent self-employed for these age and sex categories in the United States in 2003 and 2009

Year	Age category	Percent self-employed					
		Male			Female		
		Unincorporated	Incorporated	Total	Unincorporated	Incorporated	Total
2003*	45–54	10.5	4.8	15.3	6.8	2.7	9.5
	55–64	14.1	6.1	20.2	9.0	3.7	12.7
	65+	22.8	7.8	30.6	14.3	3.7	18.0
2009†	45–54	9.9	5.3	15.2	6.3	3.1	9.4
	55–64	11.9	6.2	18.1	8.0	3.5	11.5
	65+	21.4	7.7	29.1	14.0	4.4	18.4
Average	45–54			15.25			9.45
	55–64			19.15			12.10
	65+			29.85			18.20

* Hipple SF. Self-employment in the United States: an Update. Monthly Labor Review July 2004; 13–23.
† Hipple SF. Self-employment in the United States. Monthly Labor Review September 2010; 17–32.

Equation A2. Percent self-employed in the United States in 2006, sex and age standardized to the REGARDS stage 1 sample:

$$\frac{1336 \times 15.25\% + 1586 \times 19.15\% + 739 \times 29.85\% + 2221 \times 9.45\% + 2928 \times 12.10\% + 1053 \times 18.20\%}{1336 + 1586 + 739 + 2221 + 2928 + 1053} = 15.0\%$$

Summary

The fraction of REGARDS participants who reported being self-employed at enrollment (22.7%) is higher than the US population (15.0%, sex and age adjusted; 16.5%, age adjusted).