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The Role of Physical, Cognitive, and Interpersonal Occupational Requirements and Working Conditions on Disability and Retirement

Abstract

We examine of the role of physical and mental job requirements, as well as hazardous working conditions, on retirement and disability among older individuals in the United States. By linking occupation-level data on job requirements from the Occupational Requirements Survey (ORS) to individual-level data from the Health and Retirement Study (HRS), we create composite indices for physical activities and the physical work environment, as well as two indices of mental job requirements related to job autonomy and flexibility index, and being supervised and working with the pubic. Using data from the HRS Life History Mail Survey, we merge these indices to the HRS panel using the most important occupation held by the individual in her prime years. We find that a 1 standard deviation (SD) increase in the physical activity and physical work environment indices are associated with a 10 to 13 percentage point (pp) increase in the probability of being retired and a 3 to 5 pp increase in the probability of transitioning into retirement. The associations of these indices with disability outcomes follow the same patterns as retirement, but they are lower in magnitude. A 1 SD increase in job autonomy/flexibility is associated with a 22 pp decrease in the probability of being retired and a 12 pp decrease in retirement transitions, but it does not predict disability outcomes. Finally, the effects of physically demanding and hazardous jobs on labor force exit are concentrated among men and low-educated workers, while delays in retirement predicted by higher job autonomy and flexibility are driven by college-educated workers.

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1. **Introduction**

Dramatic increases in life expectancy in recent decades, coupled with no change in the youngest claiming age for Social Security benefits (62), have tended to increase the proportion of an individual's life spent in retirement. This phenomenon has slowed labor force growth (Maestas, Mullen, and Powell 2016) and presents challenges to the financial sustainability of Social Security and other public programs (Gruber and Wise 2004). If delaying disability and retirement is a policy goal, improving working conditions related to physical workload, job control, and psychological job stress, which are increasingly identified as risk factors for disability and retirement (Blekesaune and Solem 2005; Lahelma et al. 2012), may prove effective. This is all the more important when more than half of American workers are exposed to unpleasant or potentially dangerous working conditions, including heavy vibrations, loud noises, extreme temperatures, hazardous contaminants, and verbal abuse, that disproportionally affect individuals without a college education (Maestas et al. 2017).

However, improving working conditions does not automatically translate into all older individuals being able to work longer even if they are willing. The effectiveness of such policies will ultimately depend on factors such as the individual's health and the nature of job demands at work (Lopez Garcia, Maestas, and Mullen 2019). Understanding how occupational requirements and adverse environmental exposure drive disability and retirement is important for projecting the long-run sustainability of the Social Security and Social Security Disability Insurance programs, and designing policies to encourage individuals with disabilities or advanced age to work longer. The recent rapid expansion of telecommuting during the COVID-19 pandemic, with its attendant effects on sedentary work and cognitive and interpersonal job demands, further underscores the importance of understanding how working conditions affect disability and retirement transitions.

In this paper, we examine the association between physical job demands (e.g., lifting, stooping, crouching), the physical work environment (e.g., exposure to heat, cold, humidity, noise), and mental job characteristics (e.g., job autonomy, flexibility, and the social skills the job demands) with retirement and disability status and transitions, and how these associations vary by gender and education among individuals near retirement in the United States. For our empirical analysis, disability is defined as a binary variable that takes value 1 if the individual reports having any work-limiting health problem and 0 otherwise. Using rich information from Occupational Requirements Survey's (ORS) Wave 2 of the, we first study the structure and properties of ORS data and implement robust strategies to address missing data on job traits across occupations coded at the four-digit census code level. We then compare measures of physical and mental job demands, as well as the physical work environment, with similar metrics from the Occupational Information Network (O*NET) to identify the job traits that exhibit good statistical properties and concurrent validity. Using validated job requirements only, we construct composite indices of job demands: the physical activity index, the physical work environment index, the job autonomy/flexibility index, and the supervised/work with public index. Next, using restricted individual-level data from the Health and Retirement Study (HRS) and the Life History Mail Survey (LHMS), we identify the most important occupation held by the individual in her prime years, and use that occupation to merge our job demand indices to the HRS panel using four-digit census occupation codes. Finally, we estimate regression models to explore how physical and mental job requirements, and the physical work environment, predict retirement and disability status, as well transitions into retirement and disability. and study heterogeneous associations between job demands and retirement by gender and education. Our originally proposed empirical analysis considered the study of heterogeneous transitions into retirement including transitions from full- to part-time work, and from full-time work into partial retirement. However, the high level of missing data for some job traits and the lack of information on the job history for a fraction of our sample of HRS respondents (discussed below), limited the statistical power of our merged data sets to estimate robust associations between job demands and more nuanced definitions of work and retirement status. We hope to address this analysis in future research when the data collection of ORS's Wave 2 is completed.

We find that a 1 standard deviation (SD) increase in our physical activity index is associated with a 10 percentage point (pp) increase in the probability of being retired and a 5 pp increase in the probability of transitioning into retirement. The same increase in the physical environment index is associated with a 13 pp increase in the probability of being retired and a 6 pp increase in the probability of transitioning into retirement. In turn, 1 SD increase in our job autonomy/flexibility index is associated with a 22 pp decrease in the probability of being retired, and a 12 pp decrease in the probability of transitioning into retirement: The supervised/work with public index shows the same associations but in opposite directions, suggesting that this index captures low autonomy and low flexibility job traits.

In terms of disability outcomes, only physical job demands have economically significant associations with disability status and transitions into disability. Specifically, a 1 SD increase in physical activity index is associated with a 5 pp increase in the probability of being disabled (having a work-limiting health problem) and with a 3 pp increase in the probability of transitioning into disability. The same increase in the physical work environment index is associated with a 3 pp increase in the probability of being disabled, and with a 2 pp increase in the probability of transitioning into disability.

Lastly, we find significant heterogeneity in how job demands affect retirement and disability: Even though all workers in physically demanding and hazardous jobs tend to transition into retirement and disability earlier, men and low-educated workers do so even earlier than their counterparts. In turn, while all workers in occupations characterized by high job autonomy and flexibility tend to transition into retirement and disability later, this effect is much more pronounced among college-educated workers.

2. Review of the previous literature

While working conditions are a strong predictor of labor force exit (Böckerman and Ilmakunnas 2020), poor health is the most commonly cited reason for exit from paid employment through disability pension and early retirement (van Rijn et al. 2014). A large body of studies, many of them using the HRS, have found that physical health plays a large role in the retirement timing (Solem et al. 2016; Reeuwijk et al. 2017; Blundell et al. 2020; French 2005; McGarry 2004; McGonagle et al. 2015) especially in early and unplanned labor force exit (Dwyer and Mitchell 1999), as well as in perceptions of forced retirement (Szinovacz and Davey 2005). Physical job strains and low autonomy or job control have been found to be important risk factors of disability retirement in Scandinavian countries (Blekesaune and Solem 2005; Lahelma et al. 2012). Whether and how poor health limits work greatly depends on the interaction between physical and mental functional abilities and occupational demands (Lopez Garcia, Maestas, and Mullen 2019). Given the role of physical and mental health on the timing of retirement and disability, it is important to understand how physical and mental job demands, as well as the physical work environment, directly influence retirement decisions and disability outcomes. The push/pull model of retirement (Shultz, Morton, and Weckerle 1998; Barnes-Farrell 2003) suggest that some workers are pushed into retirement due to declining health, and/or inability to maintain performance requirements, while others are pulled toward retirement by their increased desire for leisure or family caregiving responsibilities. According to this model, job conditions are related to pushes into retirement and disability transitions (Fisher, Chaffee, and Sonnega 2016).

The existing research documenting the role of job demands on labor supply transitions later in life in the United States has largely relied either on subjective assessments of job demands from household surveys or on merged occupation-level data from O*NET, and results from these studies are mixed and even contradictory. For example, (Angrisani et al. 2013) and (Aaron and Callan 2011), both using subjective data from the HRS, find conflicting results about the role of work's physical strain on retirement timing. Among studies using objective measures of job demands from O*NET, Mcfall et al. (2015) find that subjective measures from the HRS are more predictive of transitions into retirement than a selection of O*NET physical, emotional and cognitive items that are likely to decline with age. Angrisani, Kapteyn, and Meijer

(2016) find the opposite using more heterogeneous indices, including the full set of O*NET items. Moreover, while O*NET has become the most popular data source to study job attributes in recent years, Handel (2016) points out several weaknesses with the O*NET data, including the nature of survey respondents (job incumbents for which there is no background information versus job analysts), significant gaps and duplication in content, overly complex and vague underlying constructs, and the fact that O*NET focuses more on abilities than functional limitations to perform jobs. More recently, Hudomiet et al. (2021) use the RAND American Life Panel to examine the relationship between job characteristics and the subjective conditional probability of working at age 70. They find consistent linkages between a desire to work at age 70 and hours flexibility. They also find that job stress, physical and cognitive job demands, the option to telecommute, and commute times were all predictive of a desire to work at age 70. Similarly, Stengård et al. (2022) using Swedish panel data show that physically demanding job tasks and work environments increased retirement among blue collar workers. Sjöberg (2022) shows that poor working conditions are associated with increased likelihood of early labor market exit, but they are associated with worse post-retirement quality of life.

3. Data

We combine four data sources in this paper. The first one is the Occupational Requirements Survey (ORS), collected by the U.S. Bureau of Labor Statistics. The ORS supplies information on the physical demands, environmental conditions, mental and cognitive demands, and vocational preparation that are required in each occupation. The ORS employs field economists to interview human resources specialists, occupational safety managers, or supervisors at selected companies about job requirements at that firm. The data used in this analysis come from Wave 2 of the 2021 public-use survey. For each requirement, the ORS reports a mixture of categorical and continuous variables. In this research, we use two variable types: a) the percentage of workers in each occupation subject to a given requirement (e.g., the percentage of workers in an occupation that requires gross manipulation); and b) the (standardized) average hours required in a typical working day (e.g., sitting or standing).

The second data source is the O*NET, version 23.3 released in 2018. It has almost 800 detailed occupations at the six-digit level of Standard Occupational Classification (SOC) codes and measures more than 200 job traits, including abilities, skills, and knowledge required to perform occupations, as well as work context and work characteristics. Generally, it provides a distribution of the characteristic for an occupation, e.g., mean, and standard deviation, or probabilities of discrete values. We use the O*NET data solely for comparison and validation of ORS measures.

The third data source is the HRS, a longitudinal household survey representing the noninstitutionalized U.S. population older than 50. Respondents are surveyed every two years, allowing us to track transitions from work into retirement and disability status. We use the RAND version of HRS, version P, with restricted version access to gather occupational information at the four-digit census code level. The HRS core questionnaire provides information about individual demographics, labor force status, financial situation, health status, and household composition. We use the HRS variable on self-reported labor force status to identify whether an individual is retired or not in a given year, and whether the individual transitioned from working full- or part-time on a given period to full retirement in the next period. Our final HRS sample consists of all individuals ages 51 to 70 in 2004 (Wave 7) who were followed across Waves 7 to 12 (N= 6,982 respondents).

Finally, we use the Life History Mail Survey (LHMS), a survey on HRS respondents who were in the sample as of the 2016 wave, which includes detailed information on occupational history. While the HRS includes information on the individual's occupations held after age 51, later-life jobs might not reflect the cumulative exposure to occupational requirements during the prime years, which are more likely to explain later life labor outcomes. It is likely that workers in their late career anticipate their retirement income needs and may make occupational and career choices that are endogenous to their anticipated retirement age. By using the most important occupation early in a respondent's career, we limit the endogenous selection of occupation related to retirement decisions. The LHMS asks respondents to report the most important occupation held between the ages 30 to 40, as well as a list of the 10 most important jobs held until the age of 50. This allows us to identify the individual's most important occupation held during the prime years.

Below we provide a detailed description of the public use ORS data. We then describe how we identify the most important occupation held by the individual in her prime years, which we use to merge the ORS data to the HRS panel. We then describe how we construct our analytic sample and variables using the HRS data. In Appendix A we describe the O*NET data, focusing on the occupational requirement measures that are comparable to the ORS measures, and we examine the concurrent validity between the ORS and O*NET measures.

3.1 The Occupational Requirement Survey

The first wave of ORS, collected over a three-year period between 2015 and 2018, supplies information on the physical demands, environmental conditions, and vocational preparation required in each occupation. The second wave, planned for collection over five years from September 2018 to July 2023, includes the same information and adds new information on cognitive and mental job requirements such as job autonomy and flexibility, social skills, and cognitive demands. For this research, we use preliminary second wave data through July 2021. The ORS Wave 2 data contain occupational requirements for 43 physical traits organized in 16 aggregate groups, 10 environmental conditions, and 12 mental requirements. While ORS provides data for 420 occupations at the six-digit 2010 Standard Occupational Classification (SOC) level, only 390 of these occupations contain some information on physical and mental job traits, and environmental conditions. For each job trait, ORS provides a mix of categorical and continuous measures, for a total of 341 variables across physical and mental job requirements, as well as environmental conditions. However, as we will discuss below in more detail, some variables are missing for some job traits, and data on some job traits are unavailable for a significant number of occupations.

In the public-use ORS, categorical variables measure the percentage of workers in a given occupation who are subject to a given requirement, for example, the percentage of workers in an occupation that requires gross manipulation. For some job traits, ORS also provides estimates of the percent of workers subject to a given requirement for a given level of frequency: seldom, occasionally, frequently, or constantly. Continuous variables include selected summary statistics by occupation reflecting how much time certain job traits are required in a typical working day. For example, the ORS includes variables for the average number of hours spent sitting by occupation, as well as the 10th, 25th, 50th, 75th, and 90th percentiles of hours spent sitting by occupation. Table 1 provides an overview of the variable types available for each physical job requirement trait, aggregated into 16 groups; Table 2 provides an overview for the environmental conditions; and Table 3 provides an overview of the variables available for mental job requirements.

Table 1: Physical job requirements and data structure

		Type of Variable		
Name of Job Requirement		Percent Workers Job Trait Required	Frequency: Category levels	Duration: Mean /Percentiles
1	Gross manipulations, both hands	X	X	-
2	Fine manipulation, both hands	X	X	-
3	Foot or leg controls	X	X	-
4	Standing	-	-	X
5	Sitting	-	-	X
6	Keyboarding	X	X	-
7	Verbal communication	X	X	-
8	Lifting and carrying	-	-	X
9	Driving	X	-	-
10	Climbing			
	Structural ramps or stairs	X	X	-
	Work-related ramps or stairs	X	X	-
	Ladders, ropes, or scaffolds	X	X	-
11	Low postures	X	X	
	Crawling	X	X	-
	Crouching	X	X	-
	Stooping	X	X	-
	Kneeling	X	X	-
12	Reaching			
	Reaching at or below the shoulder	X	X	-
	Reaching overhead	X	X	-
13	Pushing and pulling			
	With feet only	X	X	-
	With feet/legs	X	X	-
	With hands/arms	X	X	-
14	Strength level			
	Sedentary	X	-	-
	Light work	X	-	-
	Medium work	X	-	-
	Heavy work	X	-	-
	Very heavy work	X	-	-
15	Vision			
	Far	X	-	-
	Near	X	-	-
	Peripheral	X	-	-
16	Hearing			
	In person speech	X	-	-
	Remote speech	X	-	-
	Telephone	X	-	-
	Other sounds	X	-	-

Table 2: Environmental working conditions and data structure

	Name of Job Requirement	Type of Variable: Percent Workers Job Trait Required	Frequency: Category levels	Duration: Mean/Percentiles
1	**Humidity**	X	X	-
2	**Extreme cold**	X	X	-
3	**Extreme heat**	X	X	-
4	**Heavy vibrations**	X	X	-
5	**High, exposed places**	X	X	-
6	**Hazardous contaminants**	X	X	-
7	**Proximity to moving mechanical parts**	X	X	-
8	**Wetness**	X	X	-
9	**Outdoors**	X	X	-
10	**Noise***	X	-	-

Note: * The percentage of workers exposed to noise is categorized by three levels of intensity levels: “quiet,” “moderate,” and “loud.”

Table 3: Mental requirements data structure

	Name of Job Requirement	Type of Variable: Percent Workers Job Trait Required	Frequency: Category levels	Duration: Mean/Percentiles
1	**Interaction with general public**	X	-	-
2	**Working around crowd**	X	-	-
3	**Supervisory duties**	X	-	-
4	**Supervisor is present**	X	-	-
5	**Basic people skills**	X	-	-
6	**Telework available**	X	-	-
7	**Ability to pause work**	X	-	-
8	**Control of workload**	X	-	-
9	**Communicating verbally**	X	X	-
10	**Work reviewed by supervisor**	X	X	-
11	**Problem solving**	X	X	-
12	**Work pace***	X	X	-

Note: *Work pace is categorized by three levels: “fast,” “slow,” and “varying working pace.”

One practical limitation of the public-use ORS data is the lack of complete information for many job traits and occupations. Specifically, the data are subject to missing variables and missing occupations. For many job traits, the variable containing the percentage of workers for whom a particular trait is required is available (corresponding to Column 1 in Tables 1, 2, and 3) but variables containing the percentage of workers subject to a requirement at a given frequency level is unavailable (Column 2). Similarly, for some job traits with continuous variables (Column 3), the mean is available but not all the percentiles. As a result, we restrict our analysis to the categorical variables in Column 1 and continuous variables containing mean levels in Column 3 of Tables 1 and 2.

A further limitation is the absence of certain occupational requirement variables for many occupations, which is particularly troublesome for some physical and mental job demands. Columns 1 and 2 of Table 4 present the percent of occupations for which each physical job requirement is observed in the ORS data, at the individual trait level (Column 1) or aggregated into a group of traits (Column 2). We group related variables for some physical job demands (e.g., climbing, low postures) in order to recover more usable observations by defining an indicator variable for whether any variable in the group is required for more than 50% of workers in an occupation. This strategy allows us to recover occupations missing one variable in a group but not all of them. Table 5 and Table 6 describe the same statistics for environmental conditions and mental job requirements, but in these cases, we do not group related variables and instead work with individual traits. Note that Tables 4 to 6 contain percentages of the 390 occupations in the database with information on physical job demands and the physical work environment. Also note that, while we present the percent of occupations with missing observations in the ORS database, this does not necessarily correspond to the percent of *workers* with missing variables since rare occupations are more likely to be excluded.

We find a low level of missing observations for most physical abilities, except for some cases such as strength (50%), hearing other sounds (77%), or driving (79%). There are very few missing observations for environmental conditions variables. Some mental job requirements, such as problem solving, communicating verbally, control of workload, and work reviewed by supervisor, exhibit large levels of missingness (above 50%) so we eventually drop them from the analysis. We recover information for missing occupations by imputation using the mean calculated for nonmissing occupations at the same two-digit SOC level. Columns 3 and 4 of Tables 4, 5 and 6 present the sample mean for job traits included in the final analysis before and after imputation. Again, the mean is calculated at the six-digit SOC occupation level for the 390 occupations in the ORS database. Generally, the means are similar without imputation for the limited occupation set and with imputation for the full occupation set.

For the remainder of the analysis, we use the 16 aggregated physical job requirements, the 10 environmental conditions, and the seven mental job requirements not dropped from the analysis, and use observed and imputed data.

Table 4: Percent of occupations observed for physical job demands

	Name of Job Traits	(1) Percentage of Occupations Observed (%): Individual	(2) Percentage of Occupations Observed (%): Aggregated	(3) Mean (before imputing)	(4) Mean (after imputing)
1	**Gross manipulation, both hands**	95%	-	89%	89%
2	**Fine manipulation, both hands**	92%	-	63%	63%
3	**Foot or leg controls**	92%	-	31%	32%
4	**Standing (% of day)**	82%	-	53%	52%
5	**Sitting (% of day)**	79%	-	49%	49%
6	**Keyboarding**	97%	-	77%	77%
7	**Verbal communication**	97%	-	96%	95%
8	**Lifting and carrying**	81%	-	25%	25%
9	**Driving**	79%	-	28%	27%
10	**Climbing**	-	96%	11%	12%
	Structural ramps or stairs	80%			
	Work-related ramps or stairs	93%			
	Ladders, ropes, or scaffolds	95%			
11	**Low postures**	93%	93%	52%	53%
	Crawling	93%			
	Crouching	87%			
	Stooping	87%			
	Kneeling	89%			
12	**Reaching**	-	94%	76%	76%
	Reaching at or below the shoulder	93%			
	Reaching overhead	84%			
13	**Pushing and pulling**	-	93%	17%	18%
	With feet/legs	92%			
	With hands/arms	91%			
14	**Strength level**	50%	50%	41%	42%
15	**Vision**	-	85%	99%	99%
	Far	83%			
	Near	92%			
	Peripheral	80%			
16	**Hearing**	-	89%	99%	99%
	Other sounds	77%			
	Remote sounds	80%			
	Telephone	75%			
	One-on-one	76%			

Notes: Imputed using SOC two-digit level means.

Table 5: Percent of occupations observed for environmental conditions

	Name of Job Traits	(1) Percentage of Occupations Observed (%): Individual	(2) Percentage of Occupations Observed (%): Aggregated	(3) Mean (before imputing)	(4) Mean (after imputing)
1	**Humidity**	98%	-	2%	2%
2	**Extreme cold**	99%	-	3%	3%
3	**Extreme heat**	99%	-	5%	5%
4	**Heavy vibrations**	98%	-	3%	3%
5	**High, exposed places**	97%	-	8%	8%
6	**Hazardous contaminants**	96%	-	9%	9%
7	**Proximity to moving mechanical parts**	96%	-	13%	14%
8	**Wetness**	96%	-	29%	29%
9	**Outdoors**	97%	-	28%	29%
10	**Noise**	99%		2%	2%

Notes: Imputed using SOC two-digit level means.

Table 6: Percent of occupations observed for cognitive and mental requirements

	Name of Job Traits	(1) Percentage of Occupations Observed (%): Individual	(2) Percentage of Occupations Observed (%): Aggregated	(3) Mean (before imputing)	(4) Mean (after imputing)
1	**Interaction with general public**	79%	-	76%	75%
2	**Working around crowd**	77%	-	4%	4%
3	**Supervisory duties**	98%	-	19%	19%
4	**Supervisor is present**	81%	-	59%	60%
5	**Basic people skills**	84%	-	70%	71%
6	**Telework available**	81%	-	10%	11%
7	**Ability to pause work**	80%	-	60%	63%
8	**Control of workload**	48%	-	-	-
9	**Communicating verbally**	46%	-	-	-
10	**Work reviewed by supervisor**	47%	-	-	-
11	**Problem solving**	39%	-	-	-
12	**Work pace**	64%	-	-	-

Notes: 1) Imputed using SOC two-digit level means; 2) job traits with the percentage of occupations observed below 50% (control of workload, communicating verbally, work reviewed by supervisor, problem solving, and work pace [fast/slow/varying work pace]) are not included in the analysis.

3.2 Constructing indices for job demands

Based on our comparison between the ORS and O*NET job requirements (presented in Appendix A), we drop from the analysis ORS measures that exhibit little variation and poor concurrent validity with O*NET, including hearing and near vision. We exclude sitting as it is almost perfectly collinear with standing/walking. In addition, we also exclude verbal communication and keyboarding as these measures exhibit an inverse correlation with both physical job demands and the physical work environment so they might reflect a different underlying construct (perhaps more cognitive). This is perhaps unsurprising since these job demands are more likely to be associated with office jobs and clerical occupations. In terms of mental job requirements, we exclude control of workload, communicating verbally, work reviewed by supervisor, and problem solving because these traits are observed for less than 50% of the occupations. We also exclude work pace because the categorical responses for this variable could not be transformed into a "percentage of workers for which this trait was required" type of variable as all the others. What remained were nine physical activity requirements, 10 measures of the physical environment of the workplace, and seven mental requirements, across observed occupations.

With these selected job traits, we conducted a series of exploratory and confirmatory factor analyses using occupation-level ORS data to determine how these job traits should be grouped (not shown). However, the predicted latent factors resulting from these analyses were not generally interpretable, and we did not use them in our analyses. As an alternative, we constructed weighted average indices of job demands across occupations, where the weight was the occupation's share of jobs in the national economy obtained from the Current Population Survey (CPS). The “physical activity” index included the nine physical activities retained from the previous analyses. The “physical environment” index included all 10 environmental conditions. For mental job requirements, we examined the correlations across the seven job traits, and the data clearly identifies two different indices (Appendix B Table B3): a “job autonomy/flexibility” that included supervisory duties, telework, ability to pause work, and basic people skills; and a “supervised/work with crowds” index that included being supervised, working with general public, and work around crowds. We standardized both indices after having merged to the full HRS sample for ease of interpreting our results.

Table 7 presents the mean standardized indices by sex and sample and shows that both “physical” indices are significantly larger for men than women, which is reflective of men holding jobs that are more physically demanding. Women also seem to have less job autonomy and flexibility in their jobs.

Table 7: Mean indices by sex, Wave 2

	Full Sample (retirement status) (N=6,711)		
	Men	**Women**	**Overall**
Physical Activity (mean)	0.135	-0.117	0.000
Physical Environment (mean)	0.112	-0.096	0.000
Job Autonomy/Flexibility (mean)	0.074	-0.064	0.000
Supervised/Work with Public (mean)	-0.065	0.076	0.000

As a final test of the validity of our indices, we examine correlations across individual job requirements included in each index and we estimate the Cronbach’s alpha to examine the internal consistency of both indices. Appendix B’s Tables B1 and B2 show correlations across individual items for the physical activity index and the physical environment index, respectively, for the full sample of individuals (N=6,671).

The individual elements of the physical activity index (perhaps with the exception of driving) are strongly positively correlated with each other, and the same for individual elements of the physical environment index (perhaps with the exception of exposure to cold). Similar correlations can be seen for the subsample of individuals examining retirement transitions and disability (not shown). Table B3 in the Appendix B shows the correlations across mental job requirements, which demonstrates that items are strongly positively correlated within each of our two mental job demand indices, and inversely related across indices. We also find that our indices exhibit a very high internal consistency, with an estimated Cronbach's alpha of 0.94 for the physical activity index, 0.91 for the physical environment index, 0.83 for the job autonomy/flexibility index, and 0.70 for the supervised/work with public index.

3.3 The Health and Retirement Survey

The RAND Enhanced fat files of the HRS data, Version P, includes rich longitudinal information on the individual's retirement outcomes, as well as on background variables that we use as controls in our empirical specification, including age, gender, education, marital status, health status, cognition status, earnings, availability of DB/DC pension plans, availability of health insurance, and the spouse's age. We restrict our analysis to the data collected from 2004 to 2016 (seven waves) and respondents ages 51 to 70 in 2004 followed across waves, totaling 6,982 respondents. Of them, 6,711 respondents were matched with ORS data (96% match rate). Individuals not matched had missing information about their past jobs and were mostly older and already retired in Wave 7.

Retirement outcomes include the retirement status in each wave based on the self-reported labor force status, as well as transitions from “working” in period *t* to “retired/unemployed or not in the labor force” in period $t+1$, also based on labor force status. As outlined above, we define disability status creating a binary variable that takes value 1 if the individual reports having any impairment or health problem that limits the kind or amount of paid work she could do, and 0 otherwise. In order to isolate labor exits due to disability, as opposed to other motives such as Social Security incentives to retire at age 62, we restrict the sample only to individuals who are younger than 62. An individual is considered to transition into disability if she is “working” in period *t* and her disability status is equal to 1 in period $t+1$.

Ideally, we would like to merge occupational job requirements from ORS to HRS respondents by using the most important occupation (at four-digit level census occupation code) held by the individual during her prime years, which is more likely to predict labor supply transitions later in life than using the first observed occupation in the HRS panel. We attempted to identify such occupations using LHMS data on the self-reported most important occupation held during ages 30 to 40. This attempt was only partially successful as this variable was unavailable in the LHMS for 49% of HRS respondents. To address this problem, we combine LHMS and HRS data on occupations adopting the following three-step strategy (Table 8): a) assign the most important occupation held during prime years if available in the LHMS (available for 51% of HRS respondents); b) if information in a) is missing, assign the occupation with the longest tenure between ages 25 and 50 based on the history of the most important 10 occupations reported in the LHMS (7%); and c) assign the occupation observed in the HRS panel at the entering wave if there is no available job history in the LHMS (42% of HRS sample).

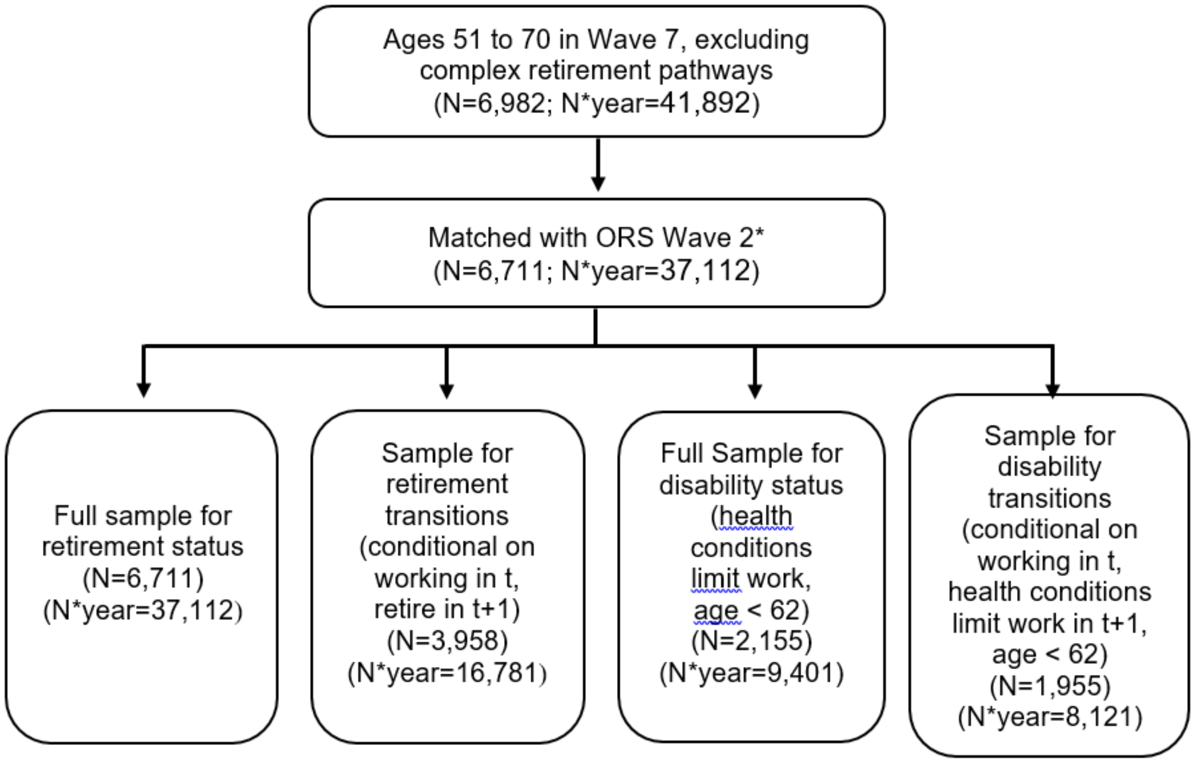
Table 8: LHMS and HRS data on occupation

Strategy	Data	Sample Size (PN)
Use most important occupation held during prime years (age 30-40)	LHMS	3,411 (51%)
Assign the occupation with the longest tenure between ages 25 and 50	LHMS	481 (7%)
Assign the occupation observed in the HRS panel at the entering wave	HRS	2,819 (42%)

Figure 1 depicts the final sample sizes for analyses. The total number of person-year observations for the examination of retirement status is 37,112 (corresponding to N=6,711 individuals) and for retirement transitions is 16,781 (corresponding to N=3,958 individuals).[1] Because the analysis of disability outcomes is restricted to individuals younger than 62, the sample sizes are smaller and equal to 9,401 person-year observations for disability status (corresponding to N=2,155 individuals), and 8,121 for disability transitions (corresponding to N=1,955 individuals).

[1] The remaining 6,711-3,958=2,753 individuals excluded from the retirement transition sample include “never working” individuals who were already retired in Wave 7, as well as “always working” individuals who were continuously working across the six waves of HRS included in the analysis.

Figure 1: Sample size and restrictions



Notes: * We use the following occupation information to match the HRS with the ORS Wave 2: 1) use most important occupation between ages 30 and 40 in LHMS; 2) supplement with the longest tenure occupation between ages 25 and 50 in LHMS; 3) supplement with first occupation at the entering wave in the HRS

Table 9 presents summary statistics for the relevant dependent and control variables. In the full sample (retirement status sample in Column 1), 51% of individuals report to be already retired, the average age is 66 years old, 53% are women, 51% are college-educated, 71% are in a couple, 25% have a DB/DC pension plan and 37% have health insurance. In comparison, individuals whom we observe transitioning from working into full retirement (Column 2) are generally younger (average of 63 years old), slightly more educated, and are more likely to have a pension plan and health insurance. In sample we use to study disability status (Column 3), only 10% of individuals report to have an impairment or health problem that limit their work for pay, they are much younger on (57 years old) because of the age restriction, and are more likely to have a spouse who works; otherwise, they are similar to individuals in the full sample.

Table 9: HRS descriptive statistics

	(1) Retirement Status (1=Fully Retired, 0=Otherwise)	**(2) Retirement Transition (1=Fully Retired, 0=Otherwise) Conditional on working in t**	**(3) Disability Status (1=Health Conditions Limit Work, 0=Otherwise)**	**(4) Disability Transition (1=Health Conditions Limit Work in t+1, 0=Otherwise) Conditional on working in t**
Variables	**Mean**	**Mean**	**Mean**	**Mean**
Dependent variable	0.51	0.20	0.10	0.08
Age	66.09 (6.54)	62.81 (6.14)	57.48 (6.58)	56.75 (6.86)
Female	0.53	0.50	0.50	0.51
High School	0.35	0.30	0.29	0.28
Some College	0.25	0.26	0.28	0.29
College and Above	0.26	0.34	0.34	0.36
Poor health	0.20	0.13	0.13	0.12
In a couple	0.71	0.74	0.77	0.78
Spouse working	0.29	0.44	0.52	0.54
Spouse Age Diff	3.07 (4.08)	3.19 (4.19)	3.16 (3.94)	3.04 (3.89)
Cognition Score (Standardized)	0.21 (0.88)	0.36 (0.76)	0.22 (0.84)	0.33 (0.75)
Annual Wage (log)	7.63 (5.08)	7.96 (4.35)	8.01 (4.53)	8.39 (3.90)
DB/DC Pension	0.25	0.48	0.33	0.48
Emp. Health Ins. (Own)	0.37	0.57	0.45	0.56
Emp. Health Ins. (Spouse)	0.23	0.32	0.26	0.30
N (individual-year)	37,112	16,781	9,401	8,121
N (individuals)	6,671	3,958	2,155	1,955

Note: HRS Waves 7 through 12. Standard errors in parentheses for continuous variables.

4. Empirical strategy

Our empirical analysis is divided into two steps. First, we merge our constructed composite indices of job demands (JD): physical activity, physical environment, job autonomy/flexibility, and supervised/work with public HRS data at the occupation level. Second, using this merged data, we estimate linear probability models to characterize the probability that a) an individual is retired, b) a worker transits from work in period *t* into retirement in period *t*+1, c) an individual has a disability, or d) a worker transits from work in period *t* into disability in period *t*+1, depends on our vector of job demands discussed above ($JD_{i,t}$), while controlling for a set of covariates ($X_{i,t}$), according to the following model:

$$R_{it} = \alpha_0 + \alpha_1 JD_i + X_{it}'\delta + \mu_t + \varepsilon_{it} \tag{1}$$

In Equation (1), R_{it} is the labor supply outcome, α_1 captures how occupational job demands change the propensity to either be retired/disabled or to transition into retirement/disability, and X is a vector of observed individual characteristics such as age, gender, education, race, marital status, health, and cognitive status, as well as spouse's characteristics such as age and employment status to capture potential incentives for joint retirement decisions. We also control for financial incentives to retire by including the individual's hourly wage, availability of a DB or DC pension plan, and employer-sponsored health insurance.

5. Results

5.1 Associations between job demands and retirement status and transitions

We merge our indices of job demands to the HRS panel to examine the role of physical and mental job demands, as well as the physical work environment, on retirement and disability outcomes. Table 10 presents our main results from linear probability models. We regress two types of variables for each outcome — an indicator variable taking value 1 if the individual reports to be retired (Column 1) or disabled (Column 2) at time *t*, and an indicator variable that takes value 1 if a working individual in period *t* reports to be retired (Colum 3) or disabled (Column 4) in time t+1 — on our four job demand indices and their interactions, as well as on a set of control variables described in Section 3. Regression results for control variables are reported in Tables B4 and B5 in Appendix B.

Since our indices of job demands are standardized within sample, we find that a 1 SD increase in our physical activity index is associated with a 10 pp increase in the probability of being retired, and with a 5 pp increase in the probability of transitioning from working (either full- or part-time) into retirement. Following a similar pattern, the same increase in this index is associated with 5 pp increase in the probability of having a disability, and a 2.6 pp increase in the probability of transitioning from working into disability. In turn, our physical environment index follows a very similar pattern as the physical activity index: A 1 SD increase in this index is associated with a 13 pp increase in the probability of being retired, a 6 pp increase in the probability of being disabled, a 2.5 pp increase in the probability of transitioning into retirement, and a 1.5 pp in the probability of transitioning into disability.

In terms of mental job requirements, a 1 SD increase in our job autonomy/flexibility index is associated with a 22 pp decrease in the probability of being retired and a 12 pp decrease in the probability of transitioning into retirement: While it also associated with statistically significant decreases in disability status and transitions, the magnitude of the effects is very small (below 1%) and thus not economically significant. Interestingly, a 1 SD increase in the supervised/work with public index shows almost the exact same associations with retirement and disability status and transitions as the job autonomy/flexibility index but in the opposite direction (predicts early labor force exit), suggesting that this index captures the lack of control of own job.

Table 10: Effect of occupational job demands on labor supply and disability

	(1) Retirement Status based on self-reported LFS (1=Fully retired, 0=otherwise)	**(2) Disability Status based on health conditions limits work (1=Limit work, 0=otherwise)**	**(3) Retirement Transition (1=Fully retired, 0=otherwise) Conditional on working in t**	**(4) Disability Transition (1=Limits work, 0=otherwise) Conditional on working in t**
Physical Activity	0.102***	0.050***	0.050***	0.026***
(index)	(0.018)	(0.004)	(0.009)	(0.004)
Physical Environment	0.133***	0.025**	0.062***	0.015***
(index)	(0.024)	(0.013)	(0.012)	(0.003)
Job Autonomy/	-0.221***	-0.003***	-0.116***	-0.009***
Flexibility (index)	(0.016)	(0.001)	(0.007)	(0.001)
Supervised/Work	0.217***	0.003***	0.111***	0.000
with Public (index)	(0.013)	(0.000)	(0.008)	(0.001)
N (individual-year)	37,112	9,401	16,781	8,121
N (individuals)	6,671	2,155	3,958	1,915

Notes: Controls include gender, age groups, education, age difference with the spouse, indicator for whether in a couple, indicator for whether the spouse is working, indicator for poor health, cognitive test scores (word recall, backward counting, and serial 7s), annual wage (log), type of employer-sponsored pension plan (DB, DC, or DB/DC), existence of employer-provided health insurance (respondent and spouse), and time fixed effects. Statistical significance indicated by *p < 0.05. **p < 0.01. ***p < 0.001.

5.2 Heterogeneous associations by gender, age, and education

We further investigate how job demands influence retirement and disability outcomes for different subgroups. Table 11 shows results for heterogeneous associations with retirement outcomes by sex. Overall, both our physical activity and the physical environment indices are more predictive of retirement status and transitions for men than for women. A 1 SD increase in the physical activity (physical environment) index is associated with a 13 (14) pp increase in the probability of being retired for men, versus 6 (7) pp increase for women, difference that is statistically significant at the 10% level. The same increase is associated with a 10 (6) pp increase in the probability of transitioning into retirement for men, and with a 2 (4) pp increase for women. In turn, both our job autonomy/flexibility and supervised/working with public indices predict a higher delay in retirement for women than for men, though these associations are not statistically significant. The same patterns across all four indices can be observed for disability outcomes (Table 12), except that differences between men and women are no longer statistically significant for the physical activity index and become more statistically significant for the two mental job requirement indices.

Table 11: Heterogeneous associations by sex: retirement

	Retirement Status based on self-reported LFS (1=Fully retired, 0=otherwise)			Retirement Transition (1=Fully retired, 0=otherwise) Conditional on working in t		
	Men	**Women**	**p-value difference**	**Men**	**Women**	**p-value difference**
Physical Activity	0.134***	0.061***	0.063	0.100***	0.017	p < 0.001
(index)	(0.029)	(0.023)		(0.016)	(0.012)	
Physical Environment	0.138***	0.070*	0.078	0.060***	0.038*	0.092
(index)	(0.030)	(0.040)		(0.015)	(0.021)	
Job Autonomy/	-0.228***	-0.266***	0.268	-0.109***	-0.143***	0.103
Flexibility (index)	(0.023)	(0.023)		(0.008)	(0.012)	
Supervised/Work	0.188***	0.211***	0.101	0.115***	0.143***	0.102
with Public (index)	(0.017)	(0.022)		(0.012)	(0.012)	
N (individual-year)	17,960	19,152		8,059	8,722	
N (individuals)	3,265	3,406		1,868	2,090	

Notes: Controls include age groups, education, age difference with the spouse, indicator for whether in a couple, indicator for whether the spouse is working, indicator for poor health, cognitive test scores (word recall, backward counting, and serial 7s), annual wage (log), type of employer-sponsored pension plan (DB, DC, or DB/DC), existence of employer-provided health insurance (respondent and spouse), and time fixed effects. Statistical significance indicated by *p < 0.05. **p < 0.01. ***p < 0.001.

Table 12: Heterogeneous associations by sex: disability

	Disability Status based on health conditions limits work (1=Health limits work, 0=otherwise)			Disability Transition (1=Health limits work, 0=otherwise) Conditional on working in t		
	Men	**Women**	**p-value difference**	**Men**	**Women**	**p-value difference**
Physical Activity (index)	0.077***	0.047***	0.206	0.030***	0.020***	0.155
	(0.006)	(0.005)		(0.004)	(0.004)	
Physical Environment (index)	0.067***	0.026*	0.002	0.022***	0.013***	0.103
	(0.021)	(0.014)		(0.004)	(0.004)	
Job Autonomy/ Flexibility (index)	-0.000	-0.005***	0.089	-0.004*	-0.010***	0.049
	(0.001)	(0.001)		(0.002)	(0.002)	
Supervised/Work with Public (index)	0.002***	0.006***	0.116	0.001	0.004**	0.001
	(0.000)	(0.001)		(0.001)	(0.002)	
N (individual-year)	4,456	4,945		3,624	4,497	
N (individuals)	1,036	1,119		841	1,074	

Notes: Controls include age groups, education, age difference with the spouse, indicator for whether in a couple, indicator for whether the spouse is working, indicator for poor health, cognitive test scores (word recall, backward counting, and serial 7s), annual wage (log), type of employer-sponsored pension plan (DB, DC, or DB/DC), existence of employer-provided health insurance (respondent and spouse), and time fixed effects. Statistical significance indicated by *p < 0.05. **p < 0.01. ***p < 0.001.

Tables 13 and 14 analyze heterogeneous associations by educational level for retirement and disability outcomes, respectively. Reflecting the fact that less skilled workers tend to hold jobs that are more hazardous and offer less autonomy and flexibility than those held by more skilled workers, we find that the physical environment is significantly more predictive of retirement status and transitions into retirement among individuals without a college degree than for those with a college degree or more. We also find that job autonomy and flexibility is significantly more predictive of delays in retirement among college-educated workers than those without a college degree. While the physical activity index exhibits similar patterns to the physical work environment index and the supervised/work with crowd index has similar associations to the job autonomy/flexibility index but in the opposite directions, these associations are not statistically significant. A 1 SD increase in the physical environment index is associated with a 14 pp and a 11 pp increase in the probability of being retired or transitioning into retirement, respectively, for those without a college degree, and with a 5 pp and a 3 pp increase for those with a college degree, differences that are statistically significant ($p < 0.001$). The same increase in our job autonomy and flexibility index is associated with just a 9 pp and a 6 pp increase in the probability of being retired and transitioning into retirement, respectively, for those without a college degree, but with a 22 pp and a 15 pp increase in the probability of being retired and transitioning into retirement, respectively, for those with a college degree ($p < 0.001$).

Table 13: Heterogeneous associations by education: retirement

	Retirement Status based on self-reported LFS (1=Fully retired, 0=otherwise)			**Retirement Transition (1=Fully retired, 0=otherwise) Conditional on working in t**		
	Below College	**College and Above**	**p-value difference**	**Below College**	**College and Above**	**p-value difference**
Physical Activity (index)	0.136***	0.112***	0.628	0.109***	0.074***	0.236
	(0.048)	(0.019)		(0.024)	(0.010)	
Physical Environment (index)	0.144***	0.050**	p < 0.001	0.113***	0.032**	p < 0.001
	(0.070)	(0.025)		(0.035)	(0.013)	
Job Autonomy/ Flexibility (index)	-0.094***	-0.222***	p < 0.001	-0.061***	-0.153***	p < 0.001
	(0.020)	(0.027)		(0.011)	(0.013)	
Supervised/Work with Public (index)	0.185***	0.200***	0.642	0.084***	0.106***	0.155
	(0.024)	(0.016)		(0.012)	(0.008)	
N (individual-year)	26,058	11,054		11,470	5,311	
N (individuals)	4,639	2,032		2,706	1,252	

Notes: Controls include gender, age groups, age difference with the spouse, indicator for whether in a couple, indicator for whether the spouse is working, indicator for poor health, cognitive test scores (word recall, backward counting, and serial 7s), annual wage (log), type of employer-sponsored pension plan (DB, DC, or DB/DC), existence of employer-provided health insurance (respondent and spouse), and time fixed effects. Statistical significance indicated by *p < 0.05. **p < 0.01. ***p < 0.001.

Table 14: Heterogeneous associations by education: disability

	Disability Status based on health conditions limits work (1=Health limits work, 0=otherwise)			**Disability Transition (1=Health limits work, 0=otherwise) Conditional on working in t**		
	Below College	**College and Above**	**p-value difference**	**Below College**	**College and Above**	**p-value difference**
Physical Activity	0.052***	0.036***	0.149	0.040***	0.018***	0.106
(index)	(0.009)	(0.005)		(0.014)	(0.004)	
Physical Environment	0.056***	0.024*	0.062	0.019***	0.005	0.003
(index)	(0.017)	(0.013)		(0.003)	(0.010)	
Job Autonomy/	-0.001	-0.005***	0.044	-0.004**	-0.010***	0.001
Flexibility (index)	(0.001)	(0.001)		(0.002)	(0.002)	
Supervised/Work	0.003***	0.002***	0.545	0.001	0.000	0.738
with Public (index)	(0.000)	(0.000)		(0.001)	(0.001)	
N (individual-year)	6,463	2,938		5,414	2,707	
N (individuals)	1,503	652		1,277	638	

Notes: Controls include gender, age groups, age difference with the spouse, indicator for whether in a couple, indicator for whether the spouse is working, indicator for poor health, cognitive test scores (word recall, backward counting, and serial 7s), annual wage (log), type of employer-sponsored pension plan (DB, DC, or DB/DC), existence of employer-provided health insurance (respondent and spouse), and time fixed effects. Statistical significance indicated by *p < 0.05. **p < 0.01. ***p < 0.001.

Finally, in Table 15 we investigate heterogeneous associations by respondent's age, but only for retirement outcomes because the disability sample is truncated at age 62. Overall, we do not find significant differences for any index and any retirement outcome between individuals above the median age in the sample (67 years old across all waves) and those below the median age.

Table 15: Heterogeneous associations by age: retirement

	Retirement Status based on self-reported LFS (1=Fully retired, 0=otherwise)			Retirement Transition (1=Fully retired, 0=otherwise) Conditional on working in t		
	Young	**Old**	**p-value difference**	**Young**	**Old**	**p-value difference**
Physical Activity	0.078***	0.119***	0.253	0.048***	0.054***	0.462
(index)	(0.024)	(0.026)		(0.013)	(0.012)	
Physical Environment	0.130***	0.142***	0.810	0.056***	0.067***	0.654
(index)	(0.034)	(0.033)		(0.018)	(0.017)	
Job Autonomy/	-0.208***	-0.202***	0.854	-0.117***	-0.097***	0.158
Flexibility (index)	(0.021)	(0.024)		(0.010)	(0.009)	
Supervised/Work	0.210***	0.196***	0.634	0.103***	0.100***	0.858
with Public (index)	(0.020)	(0.018)		(0.013)	(0.011)	
N (individual-year)	20,258	16,854		9,086	7,695	
N (individuals)	3,662	3,010		2,143	1,815	

Notes: Controls include gender, education, age difference with the spouse, indicator for whether in a couple, indicator for whether the spouse is working, indicator for poor health, cognitive test scores (word recall, backward counting, and serial 7s), annual wage (log), type of employer-sponsored pension plan (DB, DC, or DB/DC), existence of employer-provided health insurance (respondent and spouse), and time fixed effects. Statistical significance indicated by *p < 0.05. **p < 0.01. ***p < 0.001.

6. Conclusions

In this paper, we examine the effect of physical and mental job requirements, as well as the physical environment of the workplace, on retirement and disability status and transitions among individuals near retirement in the U.S., relating rich information on job demands at the occupational level from the ORS to labor supply outcomes from the HRS. To the best of our knowledge, our study is the first to examine the structure and properties of ORS data and implement robust strategies to address missing information on job traits across occupations, as well to examine the concurrent validity of ORS measures with similar metrics from the O*NET. Using job traits that exhibit good statistical properties and concurrent validity, we construct average indices of physical activities, the physical work environment, and two indices of mental requirements related to job autonomy/flexibility and jobs that require supervision and work with public. We merge these indices with restricted, individual-level data from the HRS using census occupation codes at the four-digit level to examine the role of these job demands on retirement and disability outcomes.

We find that both physical activities (e.g., lifting, low postures, reaching, pushing) and the physical environment (e.g., exposure to cold, heat, contaminants, noise), increase the probability of being retired and having a disability (defined as having an impairment or a work-limiting health problem), as well as transitions from working into retirement or disability. We also find that jobs that are more heavily supervised and require working with the public are related to an even higher probability of retiring earlier, while those that offer higher job autonomy and flexibility are associated with a delay in retirement. In particular, a one standard deviation increase in our physical activity index is associated with a 10 percentage point (pp) increase in the probability of being retired, and a 5 pp increase in the probability of transitioning into retirement, as well as with a 5 pp increase in the probability of being disabled and a 3 pp increase in the probability of transitioning into disability, after controlling for a series of sociodemographic variables including age, sex, education, health, financial situation, health insurance, and spouse's labor supply status and age.

The physical environment index exhibits very similar associations with retirement and disability outcomes. In turn, 1 SD increase in our job autonomy/flexibility index is associated with a 22 pp decrease in the probability of being retired and a 12 pp decrease in the probability of transitioning into retirement, with the supervised/work with public index showing the same associations but in opposite directions. We also find that mental job requirements do not predict disability outcomes. In terms of heterogeneity, we find that even though all workers in physically demanding and hazardous jobs tend to retire earlier, men and the low-educated retire even earlier than their counterparts. In turn, while all workers in occupations characterized by high job autonomy and flexibility tend to delay retirement, this effect is much more pronounced among college-educated workers.

Our results are in line with the previous literature showing the importance of using objective measures of job demands to model labor market outcomes such as retirement, but also clarify future steps in the retirement research agenda. First, if physical and mental job demands, as well as the physical work environment matter, what specific job requirements matter more and for which jobs? Performing a more detailed analysis by groups of occupations and individualizing job demands would allow us to answer these policy relevant questions. Importantly, if physical job demands and the physical work environment of the job are important predictors of retirement and disability, then can the introduction of technology, robotics, and other task-altering factors make some jobs less onerous and lead to prolonged employment? If jobs that offer more control of workers' own pace and are more flexible can delay retirement, what's the impact of the rapid expansion of telecommuting on retirement behaviors and the sustainability of Social Security programs?

Finally, there are a number of limitations for our study that can be addressed in future research. First, although our research goal was to add all mental job demands to the current analysis, unfortunately some important cognitive measures in preliminary data from Wave 2 are too incomplete at this point. Including a more comprehensive set of mental job demands that goes beyond job control and autonomy/flexibility to include cognitive measures is a top priority in our research agenda upon finalization of Wave 2 data collection. In addition, although in this paper we focus on a narrower set of labor supply outcomes due to some data limitations, in future work, when data collection of ORS's Wave 2 is completed, we plan to expand our analysis to include more detailed labor supply transitions among older individuals, including transitions from full-time to part-time jobs, from main occupations to "bridge" occupations, as well as transitions from retirement to any type of paid work or "unretirement."

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Appendix A: Concurrent validity between O*NET and ORS databases and construction of job demand indices

The Occupational Information Network (O*NET) survey version 23.3 (2018) is a comprehensive database surveying more than 200 job attributes based on ratings for 773 occupations coded at the six-digit level of the 2010 SOC system. Job attributes include required knowledge, skills, abilities, work activities, work context, and work styles (Johnson, Mermin, and Resseger 2011; Fisher et al. 2014; Belbase, Sanzenbacher, and Gillis 2015). We use ratings of the importance of each attribute for job performance measured on a scale of 1 (not important) to 5 (extremely important). The ratings are based primarily on responses from workers randomly surveyed at a sample of businesses. To examine concurrent validity between the ORS and O*NET measures, we matched each of the 16 aggregate physical job demands, 10 environmental working conditions and seven mental job demands in the ORS database to the variable in O*NET that best corresponds to the description of the ORS trait. Tables A1 and A2 in the Appendix present our map of O*NET to ORS measures for physical job demands and environmental conditions, respectively, along with the survey module containing the relevant O*NET variable.

Note that the ORS and O*NET are designed for different purposes. The ORS seeks to understand what specific physical, social, and cognitive capabilities are required to complete particular tasks essential for conducting the job, whereas the O*NET seeks to understand what knowledge, skills, abilities, and work activities are typical in a particular occupation. Because the aims of the surveys are different, the scales are different across data sources. Figure 1 illustrates the relationship between the average O*NET importance rating on a scale of 1 to 5 and the corresponding ORS physical requirement measure of the percentage of workers subject to a given occupational requirement for each occupation (using nonimputed data). The correlation between the O*NET and ORS measures are given for each trait (shown in parentheses in the figure title). Despite the different scales, we find a high-degree of consistency across the two databases for similar measures. For example, for work activities related to reaching, climbing, standing, sitting, and low postures in both the ORS and O*NET we calculate correlations across occupations (and recall not all occupations are available) at or above 0.85. Generally, correlations for most physical abilities are above 0.6. Notable exceptions include hearing in person and near vision, with very low correlations (in the range of 0.2). In these cases, the low correlations are driven by very limited variation in the ORS measures. As a result we do not include them in the construction of our index of physical job demands. All physical work environment traits exhibit good concurrent validity with their analogous O*NET measures and therefore we do not exclude any of them from the analysis (Figure A2). In terms of mental job requirements, it was not possible to find exact matches in ONET for some job traits such as telework and the ability to pause work (Figure A3). However, correlations for matched variables are moderate to high (above 50%) except for working around crowds (in the range of 0.3).

*Figure A1: Concurrent validity between ORS and O*NET physical job demands*

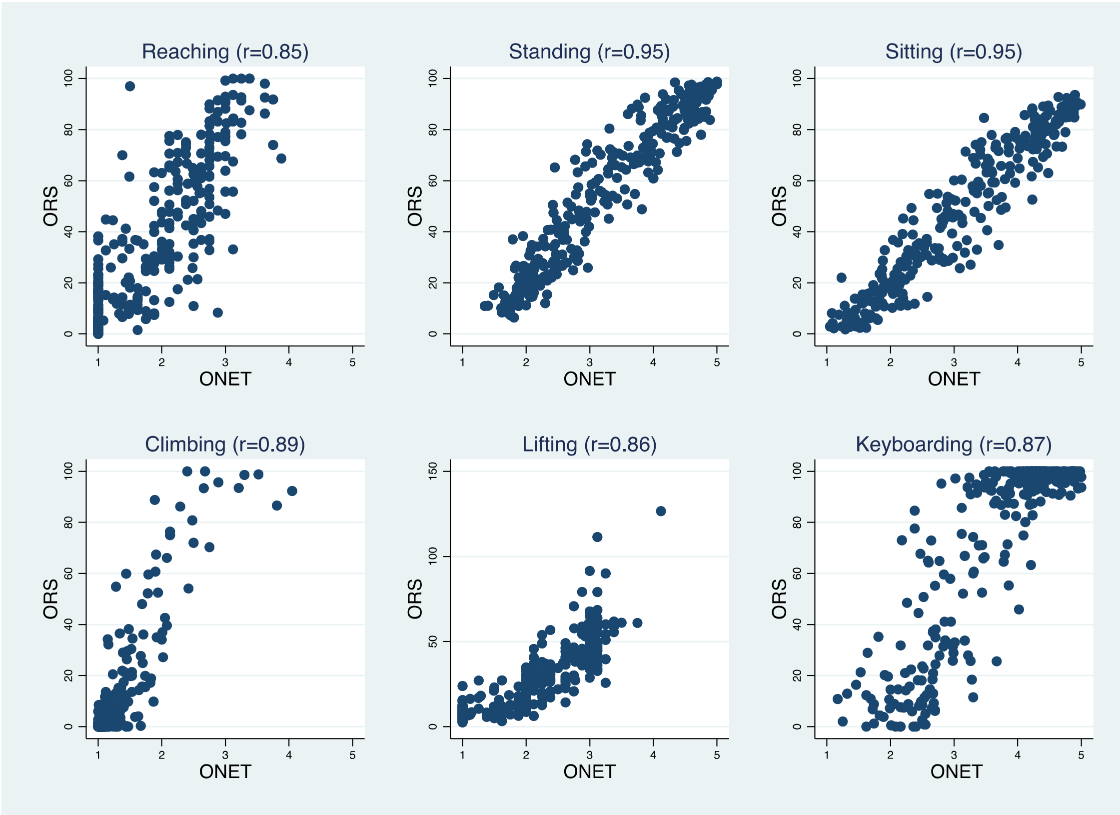

Figure A2: Concurrent validity between ORS and O*NET environmental conditions

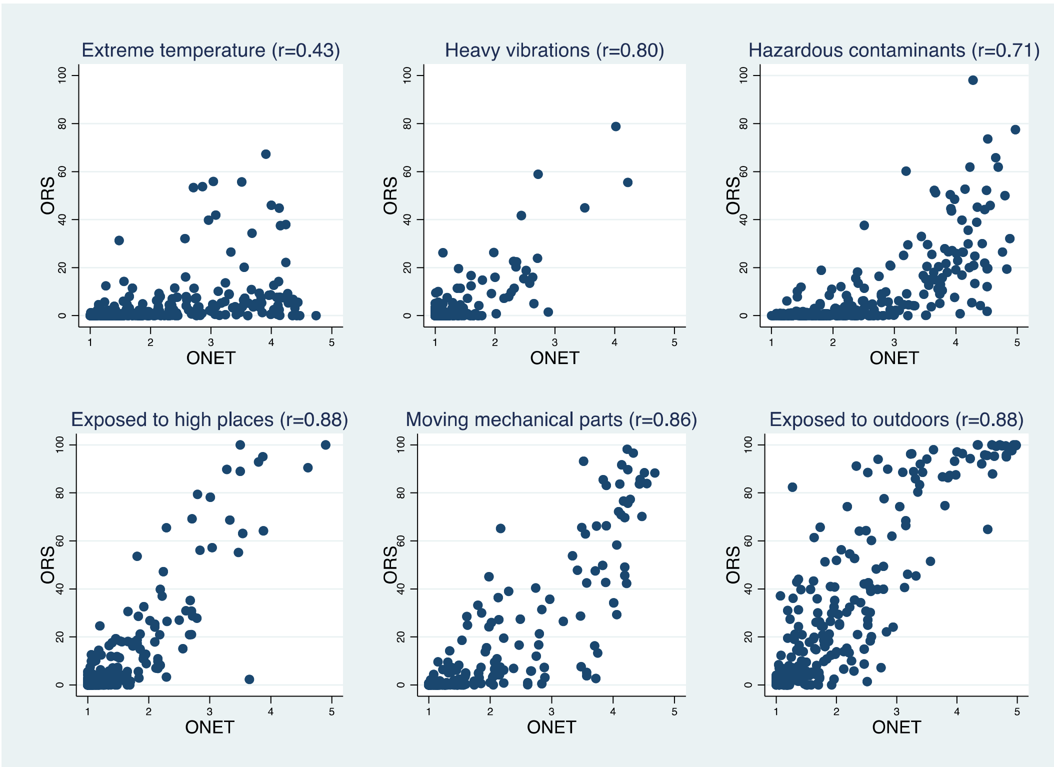

*Figure A3: Concurrent validity between ORS and O*NET mental job demands*

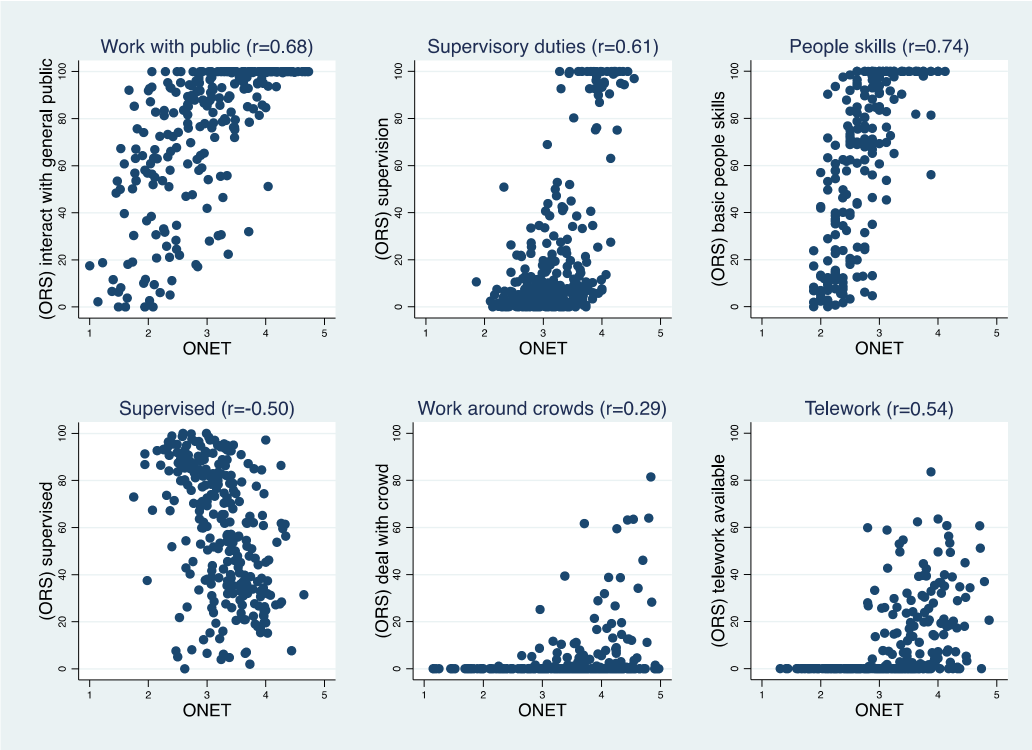

Table A1: Matching ORS and O*NET variables for physical job demands

ORS Variables	O*NET Variables	O*NET Module
Reaching: Overhead reaching; reaching at/below the shoulder	Extent Flexibility: The ability to bend, stretch, twist, or reach with your body, arms, and/or legs	Physical abilities
Pushing/Pulling: Exerting force upon an object so that the object moves away from the force; exerting force upon an object so that the object moves toward the force	Static Strength: The ability to exert maximum muscle force to lift, push, pull, or carry objects.	Physical abilities
Strength: The capacity for exertion or endurance (sedentary/light/medium/heavy/very heavy)	Static Strength: The ability to exert maximum muscle force to lift, push, pull, or carry objects.	Physical abilities
Lifting weights: Raising or lowering an object from one level to another. This includes upward pulling (lbs.)	Static Strength: The ability to exert maximum muscle force to lift, push, pull, or carry objects.	Physical abilities
Fine manipulation: Picking, pinching, touching, working primarily with fingers rather than the whole hand or arm	Finger Dexterity: The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.	Psychomotor abilities (excluded)
Gross manipulation: Seizing, holding, grasping, turning, or otherwise working with the hand(s)	Manual Dexterity: The ability to quickly move your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects.	Psychomotor abilities (excluded)
Foot/leg controls: Use of one or both feet or legs to move controls on machinery or equipment	Control Precision: The ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions.	Psychomotor abilities
Driving: Operation of a passenger vehicle or other conveyance: automobile, van, or bus	Operating Vehicles, Mechanized Devices, or Equipment: Running, maneuvering, navigating, or driving vehicles or mechanized equipment.	Work output
Standing/Walking: Remaining on one's feet in an upright position without moving about	Spent Time Standing	Work context
Sitting: In a seated position; inactive and seated or prone; sitting also includes active sitting such as riding a bike, or choosing between sitting and standing	Spend Time Sitting	Work context
Climbing: Ascending or descending ladders, scaffolding, ropes, poles and the like using feet and legs and/or hands and arms; ascending or descending ramps and/or stairs using feet and legs	Spend Time Climbing Ladders, Scaffolds, or Poles	Work context

Low postures: Crawling, kneeling, crouching, stooping	Spend Time Kneeling, Crouching, Stooping, or Crawling: How much does this job require kneeling, crouching, stooping, or crawling?	Work context
Hearing: Hearing requirements are the ability to hear, understand, and distinguish speech in person or by telephone and/or other sounds (e.g., machinery alarms, medical codes/alarms)	Hearing Sensitivity: The ability to detect or tell the differences between sounds that vary in pitch and loudness.	Sensory abilities (excluded)
Near Vision: Clarity of vision at approximately 20 inches or less, as when working with small objects or reading small print	Near Vision: The ability to see details at close range (within a few feet of the observer).	Sensory abilities (excluded)
Verbal Communication: Expressing or exchanging ideas by means of the spoken word to impart oral information to clients or the public and to convey detailed spoken instructions to other workers accurately, loudly, or quickly	Oral Comprehension: The ability to listen to and understand information and ideas presented through spoken words and sentences. Oral Expression: The ability to communicate information and ideas in speaking so others will understand.	Cognitive abilities
Keyboarding: Entering text or data into a computer or other machine by means of a keyboard. Devices include traditional keyboard, 10-key pad, touch screen, and other	Interacting with computers: Using computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.	Work activities

Source: 1) ORS Survey Collection Manual 2015 2) O*NET Resource Center: The O*NET Content Model

Table A2: Matching ORS and O*NET variables for physical work environment

ORS Variables	O*NET Variables	O*NET Module
Exposed to Cold or Heat: Exposed to extreme cold or heat (40 degrees or below when exposed 2/3 or more of the time, or 32 degrees or below when exposed up to 2/3 of the time; above 90 degrees in a dry environment, or above 85 degrees in a humid environment	Very Hot or Cold Temperatures: How often does this job require working in very hot (above 90 F degrees) or very cold (below 32 F degrees) temperatures?	Work context
Heavy Vibrations: Exposed to a shaking object(s) or surface(s) that causes a strain on the body or extremities	Exposed to Whole Body Vibration: How often does this job require exposure to whole body vibration (e.g., operate a jackhammer)?	Environ-mental conditions
Hazardous Contaminants: Exposure that negatively affects the respiratory system, eyes, skin, or other living tissue via inhalation, ingestion, or contact	Exposed to Contaminants: How often does this job require working exposed to contaminants (such as pollutants, gases, dust, or odors)?	Environ-mental conditions
Exposed to high, exposed places: Must be exposed and at risk of falling five feet or more from workers center of gravity. Must be at risk of bodily injury from falling	Exposed to High Places: How often does this job require exposure to high places?	Work context
Exposed to moving mechanical parts: Operation of or proximity to materials, mechanical parts, settings, or any moving objects (most commonly moving machinery or equipment) that could cause bodily harm.	Exposed to Hazardous Equipment: How often does this job require exposure to hazardous equipment?	Work context
Exposed to outdoors: A worker performs typical job duties outdoors, or a worker moves between different work sites during the workday	Outdoors, Exposed to Weather: How often does this job require working outdoors, exposed to all weather conditions?	Physical work conditions

Source: 1) ORS Survey Collection Manual 2015; 2) O*NET Resource Center: The O*NET Content Model

Table A3: Matching ORS and O*NET variables for cognitive and mental requirements

ORS Variables	O*NET Variables	O*NET Module
Interaction with general public (Identify settings where workers must have contact i.e., in person, via telephone, or by videoconferencing, with individuals other than coworkers, e.g., customers, clients, patients, or workers from other establishments)	Communicating and interacting Communicating with People Outside the Organization Performing for or Working Directly with the Public	Work activities
Personal contacts: People skills (People skills defined as the ability to listen, communicate, and relate to others)	Communicating and interacting Communicating with Supervisors, Peers, or Subordinates Communicating with People Outside the Organization Establishing and Maintaining Interpersonal Relationships Resolving Conflicts and Negotiating with Others	Work activities
Working around crowds (in a way that restrict their movement) (Capture the need for a job to work around large gatherings of unfamiliar people in locations like convention halls, public malls, large public beaches, airports or on airplanes, as well as mass entertainment venues like movie theatres, auditoriums, sporting events, night clubs, etc.)	Communicating and interacting Performing for or Working Directly with the Public Communicating with People Outside the Organization	Work activities
Supervisory duties (Supervising others)	Coordinating, Developing, Managing, and Advising Guiding, Directing, and Motivating Subordinates Coordinating the Work and Activities of Others Developing and Building Teams	Work activities
Problem solving (Measure the frequency workers are required to analyze issues and make decisions that have a moderate to significant level of difficulty (e.g., the full extent of issues may not be readily apparent and requires independent judgment and research or investigation)	Complex problem solving skills Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.	Skills
Personal contacts: Verbal interactions (Measure how often workers must begin verbally interacting with others while performing critical tasks (both speaking and listening)	Verbal abilities Oral Comprehension: The ability to listen to and understand information and ideas presented through spoken words and sentences.	Abilities

	Oral Expression: The ability to communicate information and ideas in speaking so others will understand.	

Source: 1) ORS Survey Collection Manual 2018 2) O*NET Resource Center: The O*NET Content Model

Appendix B: Correlation matrices and additional regression results

Table B1: Correlation matrix physical job demands, Wave 2 (full sample N=6,671)

	Climbing	Leg control	Low posture	Reaching	Pushing	Strength	Standing	Driving	Lifting
Climbing	1.00								
Leg control	0.71	1.00							
Low posture	0.70	0.73	1.00						
Reaching	0.70	0.60	0.93	1.00					
Pushing	0.60	0.71	0.88	0.83	1.00				
Strength	0.63	0.52	0.93	0.86	0.88	1.00			
Standing	0.46	0.30	0.62	0.87	0.70	0.89	1.00		
Driving	0.57	0.96	0.36	0.46	0.56	0.37	0.14	1.00	
Lifting	0.69	0.59	0.92	0.90	0.92	0.95	0.84	0.44	1.00

Table B2: Correlation matrix physical work environment, Wave 2 (full sample N=6,671)

	Humidity	Cold	Heat	Vibrate	High places	Contami-nants	Moving parts	Wetness	Outdoors	Noise
Humidity	1.00									
Cold	0.36	1.00								
Heat	0.67	0.83	1.00							
Vibration	0.52	0.00	0.60	1.00						
High places	0.48	-0.02	0.54	0.70	1.00					
Contaminants	0.59	0.07	0.59	0.84	0.77	1.00				
Moving parts	0.44	0.28	0.69	0.74	0.67	0.88	1.00			
Wetness	0.39	0.49	0.53	0.34	0.16	0.51	0.23	1.00		
Outdoors	0.53	0.05	0.34	0.73	0.60	0.62	0.56	0.44	1.00	
Noise	0.28	0.25	0.57	0.57	0.51	0.51	0.61	0.56	0.44	1.00

Table B3: Correlation matrix mental and cognitive requirements, Wave 2 (full sample N=6,671)

		Supervision	Telework	Pause Work	Self-paced	Supervised	Work with General public	Work Around crowd
Job Autonomy/ Flexibility	Supervision	1.00						
	Telework	0.48	1.00					
	Ability to pause work	0.49	0.78	1.00				
	Self-paced	0.73	0.84	0.83	1.00			
Supervised/ Work with Public	Supervised	-0.68	-0.40	-0.33	-0.63	1.00		
	Work with general public	-0.24	-0.40	-0.31	-0.32	0.35	1.00	
	Work around crowd	-0.20	-0.05	-0.20	-0.05	0.22	0.32	1.00

Table B4: Controls in labor supply regressions

	Retirement Flag based on self-reported LFP (1=Fully retired or unemployed, 0=otherwise)	Retirement Transition (1=Fully retired or unemployed, 0=otherwise) Conditional on working in t
Women	0.062***	0.041**
	(0.006)	(0.005)
56-60	0.026**	0.047***
	(0.011)	(0.009)
61-65	0.129***	0.182***
	(0.012)	(0.013)
66-70	0.262***	0.201***
	(0.012)	(0.012)
71-75	0.339***	0.319***
	(0.011)	(0.020)
>76	0.451***	0.373***
	(0.018)	(0.041)
HS or eq	-0.023	-0.003***
	(0.015)	(0.001)
Some college	-0.027*	-0.027***
	(0.017)	(0.008)
College and above	-0.028*	-0.027***
	(0.017)	(0.009)
Spouse age difference	0.001	-0.001
	(0.001)	(0.001)
In couple	0.087***	0.042***
	(0.009)	(0.011)
Spouse working	-0.110***	-0.111***
	(0.007)	(0.005)
Poor health	0.115***	0.040***
	(0.012)	(0.006)
Total cognition scores	-0.009***	-0.004***
	(0.001)	(0.001)
Log earnings	-0.089***	-0.041***
	(0.001)	(0.001)
DB Pension	-0.422***	-0.207***
	(0.018)	(0.009)
DC Pension	-0.463***	-0.221***
	(0.015)	(0.008)
DB/DC Pension	-0.425***	-0.212***
	(0.041)	(0.021)
Emp. Health ins (Own)	-0.032***	-0.019***
	(0.007)	(0.006)
Emp. Health ins (Spouse)	-0.027***	-0.048***
	(0.007)	(0.007)
Constant	0.126***	0.122***
	(0.021)	(0.035)

Table B5: Controls in disability regressions

	Disability Status based on health conditions limits work (1=Health limits work, 0=otherwise)	Disability Transition (1=Health limits work, 0=otherwise) Conditional on working in t
Women	0.008**	0.012**
	(0.004)	(0.005)
56-60	0.058***	0.062***
	(0.010)	(0.010)
61-65	0.062***	0.067***
	(0.012)	(0.012)
66-70	0.095***	0.078***
	(0.012)	(0.016)
71-75	0.099***	0.086***
	(0.011)	(0.017)
>76	0.101***	0.102***
	(0.014)	(0.035)
HS or eq	0.046***	0.019***
	(0.008)	(0.005)
Some college	-0.061***	-0.023***
	(0.009)	(0.006)
College and above	-0.025***	-0.011*
	(0.010)	(0.006)
Spouse age difference	0.001***	0.001**
	(0.000)	(0.001)
In couple	-0.080	-0.459
	(0.242)	(0.363)
Spouse working	-0.010***	-0.003
	(0.003)	(0.005)
Poor health	0.343***	0.281***
	(0.007)	(0.004)
Total cognition scores	-0.001**	-0.002***
	(0.000)	(0.001)
Log earnings	-0.007***	-0.010***
	(0.000)	(0.001)
DB Pension	-0.014**	-0.016
	(0.006)	(0.010)
DC Pension	-0.013**	-0.030***
	(0.005)	(0.008)
DB/DC Pension	-0.006	-0.023
	(0.015)	(0.022)
Emp. Health ins (Own)	-0.015***	-0.035***
	(0.004)	(0.006)
Emp. Health ins (Spouse)	-0.003	0.011
	(0.005)	(0.007)
Constant	-0.214	0.358
	(0.243)	(0.365)