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Influence of illness and unhealthy behavior on health-related early retirement in Korea: Results from a longitudinal study in Korea

Mo-Yeol KANG[1,2], Chang-gyo YOON[3] and Jin-Ha YOON[4,5]

[1]Institute for Occupational and Environmental Health, Wonjin Green Hospital, Republic of Korea, [2]Department of Preventive Medicine, Seoul National University College of Medicine, Republic of Korea, [3]Department of Preventive Medicine, Armed Forces Medical Command, Republic of Korea, [4]The Institute for Occupational Health, Yonsei University College of Medicine, Republic of Korea and [5]Department of Preventive Medicine, Yonsei University College of Medicine, Republic of Korea

Abstract: Influence of illness and unhealthy behavior on health-related early retirement in Korea: Results from a longitudinal study in Korea: Mo-Yeol KANG, *et al*. Institute for Occupational and Environmental Health, Wonjin Green Hospital, Republic of Korea—Objectives: The aim of this study was to elucidate the effect of illness and unhealthy behavior on early retirement due to health problems (ERdHP) using Korean longitudinal data. **Methods:** This study used data collected from 3,508 subjects enrolled in the first to fourth phases of the Korean Longitudinal Study of Ageing (KLoSA). This study was conducted from 2006 to 2012 using structured questionnaires on retirement, morbidities, and health-related behaviors. We adopted the Cox proportional hazard model to investigate the effects of diagnosed disease and health-related behaviors on ERdHP. **Results:** Participants who smoked, were obese, or suffered from hypertension, diabetes, malignancy, heart disease, stroke, or arthritis had a significantly higher risk of health-related early retirement after adjustment for gender, age, and occupation. Further, risk factors such as lack of exercise, stroke, arthritis, obesity, and malignancy differentially affect early retirement by gender. **Conclusions:** This is the first study, that we are aware of, to examine the effect of illness and unhealthy behavior on ERdHP in Asia, using Korean longitudinal data. We found that hypertension, diabetes, malignancy, arthritis, cardiovascular and cerebrovascular diseases, smoking, and obesity increased the risk of ERdHP. To enhance the sustainability of labor in an aging society, more studies on ERdHP are needed.
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Key words: Aging, Cox proportional hazard model, Early retirement, Gender, Korean longitudinal data

Involuntary early retirement is a serious financial concern for workers and their families[1)]. Beyond the individual level, early retirement contributes to social problems. Because most industrialized countries have an increased life expectancy and reduced birth rates, social concern has developed with regard to increasing labor force participation and decreasing involuntary retirement[2)].

Various studies have indicated that worker retired early due to illness even though they needed to work to maintain their economic lives[3)]. Illness also affects restarting work participation after retirement in old age[4)]. Some studies have shown that chronic disease affects early retirement[4)]. Furthermore, studies that used self-perceived health status to investigate the effect of illness on early retirement[5)] suggest that self-perceived health is a very important factor in the retirement process[6)]. In addition, it is important to identify specific diseases related to early retirement in order to reduce the risk of early retirement. For example, workers with psychological diseases such as depression show higher job turnover, low productivity, and eventually high retirement rates[7)]. Lower physical functioning, working error, and limitations at work are predictors of early retirement, and these factors are linked to musculoskeletal disorder[8)]. Nevertheless, few

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Correspondence to: J.-H. Yoon, The Institute for Occupational Health, Department of Preventive Medicine, Yonsei University College of Medicine 50, Yonsei-ro, Seodaemun-gu, Seoul, Republic of Korea, 120-749 (e-mail: flyinyou@gmail.com)
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studies have determined which diseases are predictors of early retirement.

Unhealthy behavior—such as smoking, problematic alcohol use, or lack of exercise—also might be an important predictor of early retirement, but this notion is controversial. Lack of physical activity predicts high risk of early retirement or home working in elderly workers[9]. However, a well-designed meta-analysis showed that lack of physical activity predicts future unemployment and receipt of a disability pension, but does not predict early retirement[10]. It was found that high physical demands at work increase the risk of early retirement in nurses, but physical activity in leisure time did not show a protective effect on early retirement[11]. In a European longitudinal study, however, high physical work demands at work and lack of physical activity during leisure time were significantly related to future early retirement[12]. A large longitudinal study reported that smokers have a dose-dependent risk of early retirement that is 5 times greater due to chronic diseases[13]. However, other longitudinal studies have not shown significant associations between smoking and risk of early retirement[12] or disability pension[5]. Another study revealed that the impact of smoking on early retirement varies by gender; smoking increases the risk of early retirement in men, but not in women[14]. Further, some studies report that obese workers who have a body mass index (BMI) of 25 or more at age 25 have an increased risk of early retirement[12]; this effect was not examined across gender, however.

According to reports of from the Organization for Economic and Co-operation and Development (OECD)[15], Korea and Japan will have the most rapidly growing populations in the world; thus, ERdHP is an urgent occupational and social concern in Eastern Asian. ERdHP has been examined in Western countries and Europe but not in Eastern Asia. Hence, investigations to reduce early retirement and increase labor force participation in Eastern Asia are needed. This study helps fill this gap by determining which illnesses and unhealthy behaviors predict ERdHP in the elderly population. We conducted a longitudinal study recruiting individuals from the Korean elderly population as participants, and stratified the analyses by gender. Our results may provide insight concerning how to reduce the early retirement rate in these aging societies.

Materials and Methods

Data collection and participants

Data were collected from a sample from the first to fourth phases of the Korean Longitudinal Study of Ageing (KLoSA) conducted by the Korean Labor Institute and Korean Employment Institute Information Service. Surveys were conducted in 2006, 2008, 2010, and 2012. The original KLoSA study population comprised South Korean adults aged 45 years or older who lived in 15 large administrative areas. In 2006, 15 major cities and provinces were selected by stratification, and 10,000 households were randomly selected. Of these 10,000 households, successful interviews were conducted in 6,171 households, and the total number of surveyed subjects was 10,254. These subjects underwent biennial follow-up.

The participants were interviewed using the Computer-Assisted Personal Interviewing method. The interviewers instructed the subjects to read the questions and input their answers themselves. The first phase of interviews was conducted from August to December 2006, the second from July to November 2008, the third from October to December 2010, and the fourth from July to December 2012. The second survey in 2008 was a follow-up with 8,688 subjects, representing 86.9% of the original sample; the third survey in 2010 was administered to 7,920 subjects, 77.2% of the original sample; and, the fourth survey in 2012 was administered to 7,486 subjects, 73.0% of the original sample.

The following inclusion/exclusion criteria were used: (1) during the first phase, workers (n=3,888) were selected from the total sample size (N=10,254), and (2) subjects 70 years of age and older during the first phase (n=233) were excluded. A total of 3,655 subjects were evaluated for eligibility after applying these inclusion/exclusion criteria. The final sample size was 3,371 after eliminating candidates with missing values (i.e., 283 subjects had missing occupational information and one subject had missing smoking status) (Fig. 1).

The KLoSA is a national public database where all identifiable information is anonymized. Interviewers provided information about study objective, methods, potential risks and benefits, and mode of compensation, and informed consent was procured from all participants prior to their participation. The subjects also agreed to participate in further scientific research. This study was approved by the Institutional Review Board of the Yonsei University Graduate School of Public Health.

Study Variables and Measurements

Temporal onset of retirement

The date of retirement was measured by the questionnaire responses. New cases of ERdHP were defined as those individuals who retired due to their health problems before their scheduled or regular retirement age in one of the follow-up surveys. All retired persons were also asked to provide the date of their retirement.

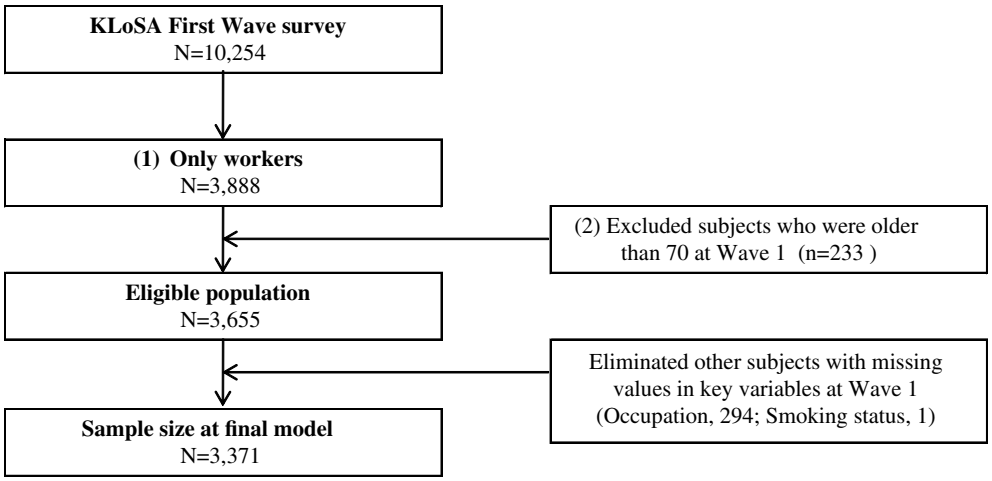

Fig. 1. Schematic diagram depicting study population.

Follow-up

The follow-up period for retirees was calculated as the difference between the date of the first survey and the date of retirement. We organized the subjects in ascending order of time for follow-up. If a subject had more than one retirement event during the study period, we chose the first event for the calculation of follow-up period. If undiagnosed subjects were lost to follow-up across the second to fourth set of interviews, their follow-up period was calculated as the difference between the date of the first survey and the date of the final survey that they completed. For the rest of the subjects who did not experience an event or were not lost to follow up, the follow-up period was calculated as the difference between the date of the first survey and last date of the forth survey.

Health status and health-related behavior

Self-perceived health status in the last 12 months was rated across 5 levels: very good, good, moderate, poor, and very poor. Information on lifestyle behaviors such as smoking habits, alcohol consumption, regular exercise, BMI, and diagnosed chronic disease were collected during the first phase of the survey in 2006. A subset of respondents reported one or more physician-diagnosed disease including hypertension, diabetes mellitus, heart disease, stroke, arthritis, malignancy, chronic lung disease, and psychological disease. Physical activity was categorized as regularly performed or not regularly performed. Regular exercise was defined as exercise more than twice per week with each session lasting at least 30 minutes. Smoking behavior was categorized as current, past, and nonsmokers. We defined problem drinkers as subjects who drank alcohol an average of 2 or more times per week, or 7 or more glasses of an alcoholic beverage for males and 5 or more for females per occasion. Body mass index was calculated as follows: weight/height^2 (kg/m^2); a BMI of ≥25.0 was categorized as obese, and a BMI between 25.0 and 23.0 was categorized as overweight according to the WHO Asia-Pacific guidelines[16].

Other covariates

The KLoSA survey includes questions about a wide array of characteristics. We used age, gender, pension income, and occupation as covariates. Income level was defined as annual household income among individuals in the study population. Occupation was categorized into 6 groups: managers and professionals; office workers; service and sales workers; agriculture, forestry, and fisheries workers; craft and machine operators and assembly workers; and manual workers.

Statistical analyses

We listed the frequencies of the baseline characteristics of the participants and compared them to each categorized variable for analysis of the general characteristics of the subjects. To explore whether diagnosed diseases and lifestyle behaviors affect ERdHP, we analyzed the distribution of each group using chi-squared tests and ANOVAs. Cox proportional hazard models were used to evaluate the effects of diagnosed diseases or lifestyle behaviors on ERdHP. Two approaches were used to assess the validity of the proportional hazards assumption. First, we examined graphs of the log-minus-log-survival functions and found that plots had grossly parallel lines. Second, we used time-dependent covariates to confirm of proportionality and found that none of the time-dependent covariates were statistically significant, suggesting the hazard is reasonably constant over time. Covariates associated with event were

determined using stepwise selection of Cox regression analysis, which chose age, gender, occupation, smoking, and hypertension as significant explanatory variables. Then an advanced model was built based on clinical significance including perceived health status, health behaviors and diseases, which have been known as potential risk factors for health-related early retirement. In the final model, we also adjusted for pension income and occupation. Even though it was not statistically significant during the stepwise selection process, socioeconomic status might be closely associated with decision to retirement. As a result, the models were comprised of Model 1 (crude), Model 2 (adjusted for age and gender), and Model 3 (adjusted for age, gender, pension income and occupation). Given that the results could be affected by gender, we performed stratified analysis according to gender. All analyses were conducted using SAS statistical software (Version 9.22, SAS Institute, Cary, NC, USA). The significance threshold was 0.05 (two-tailed).

Results

The mean age (and corresponding standard deviation/SD) of the subjects was 54.33 (± 7.02 SD) years, and 68.26% of them were male. Approximately half of the study population had no smoking history and one-fourth was obese. The most frequently diagnosed disease was hypertension (17.03%). Table 1 shows the results obtained from the preliminary analysis of the frequency of health-related early retirement according to each variable. Female, older, and manual workers were more likely to retire due to health problems. Furthermore, self-perceived health status was related to a dose-dependent risk of ERdHP (p for trend=0.0189). Moreover, subjects who did not engage in regular exercise, and those who had a diagnosed disease tended to retire early because of health problems. The remaining descriptive characteristics of the study population are listed in Table 1.

The results shown in Table 2, which presents the hazard ratios (HRs) of health-related early retirement according to characteristics of health behaviors and diagnosed diseases, show a pattern similar to the results in Table 1. In the final model, self-perceived poor health was significantly and dose-dependently associated with ERdHP. As perceived health became poorer, ERdHP risk increased (adjusted HR for ERdHP: poor perceived health=4.014; very poor=7.496). Individuals with current smoking behavior, obesity, hypertension, diabetes, malignancy, heart disease, stroke, and arthritis had a significantly higher risk of health-related early retirement after adjustment for gender, age, and occupation (adjusted HR for ERdHP: current smoker=1.525; obesity=1.361; hypertension=1.511; diabetes=1.470; malignancy=1.95; heart disease=2.174; stroke=2.215; and, arthritis=1.587). Marginally significant relationships were observed between health-related early retirement and other risk factors, including smoking history and lack of regular exercise (former smoker, HR=1.47, 95% CI=0.969–2.230; lack of exercise, HR=1.146, 95% CI=0.896–1.466). However, there were no significant relationships between health-related early retirement and problem drinking, chronic lung disease, or psychological disease.

The results of the gender-stratified analyses are presented in Tables 3 and 4. Model 3 revealed that risk factors—lack of exercise, stroke, and arthritis—have greater effects on early retirement among male workers than female workers, but that the HRs for obesity and malignancy were higher among female subjects. The gender comparison also revealed that the effect of psychological disease on early retirement is very strong among male subjects, but weak or absent among female subjects (male subjects, HR=2.933, 95% CI=0.718−11.975; female subjects, HR=1.224, 95% CI=0.387−3.871).

Discussion

To the best of our knowledge, this is the first longitudinal study that shows the influence of illness and unhealthy behavior on early retirement in the Korean elderly population. Hypertension, diabetes, malignancy, arthritis, cardiovascular, and cerebrovascular diseases predicted ERdHP risk. Furthermore, self-perceived health status was dose-dependently related to ERdHP risk, and unhealthy behavior, such as cigarette smoking and obesity, accelerated ERdHP risk. Notably, the association between the risk of ERdHP, illness, and unhealthy behaviors varied by gender.

Due to low birth rates and increased life expectancy, sustainable labor force participation is a concern in most industrialized countries. Now that legal retirement ages are rising, fewer older workers are retiring early. At the same time, older workers who have lost their job after the age of 50 have tended to remain in long-term unemployment. Retirement of older worker due to illness negatively affects the financial status of the their family[1]. In addition, poverty decreases health care accessibility. This cycle can exacerbate poverty of families and society as a whole. Hence, sustainable work and good health are increasingly a worldwide social concern[17]. Our results suggest that illness and unhealthy behavior might be important targets for strategies to reduce the risk of ERdHP.

In a nationwide study from Iran, cardiovascular disease, musculoskeletal disorder, and chronic lung diseases account for 31, 30, and 13% of case of early retirement, respectively[18]. In musculoskeletal disor-

Table 1. General characteristics of the study population of employed individuals at baseline

Characteristics	Distribution		Health-related early retirement		
	N	%	N	%	*p*-value
Demographics					
Gender					
Male	2,301	68.26	183	7.95	<0.0001
Female	1,070	31.74	142	13.27	
Age					
<50	1,096	32.51	53	4.84	<0.0001
50–55	822	24.38	60	7.3	
55–60	617	18.3	55	8.91	
60–65	443	13.14	73	16.48	
≥65	393	11.66	84	21.37	
Occupation (workers)					
Managers and professionals	566	15.92	23	4.06	0.0001
Office	313	8.8	15	4.79	
Service and sales	781	21.96	63	8.07	
Agriculture, forestry and fisheries	424	11.92	42	9.91	
Craft, device machine operators and assembly	723	20.33	45	6.22	
Manual workers	749	21.06	78	10.41	
Perceived health status					
Very good	197	5.84	7	3.55	<0.0001
Good	1,759	52.18	118	6.71	
Moderate	999	29.64	108	10.81	
Poor	376	11.15	73	19.41	
Very poor	40	1.19	19	47.5	
Health behaviors					
Smoking					
Nonsmoker	1,892	56.14	190	10.04	0.408
Ex-smoker	399	11.84	39	9.77	
Current smoker	1,079	32.02	96	8.9	
Problem drinking					
No	2,377	70.51	250	10.52	0.079
Yes	994	29.49	75	7.55	
Lack of exercise(one or more times per week)					
Yes	1,319	39.13	107	8.11	0.0022
No	2,052	60.87	218	10.62	
BMI					
Normal or underweight	1,450	43.01	134	9.24	0.0772
Overweight	1,084	32.16	94	8.67	
Obese	837	24.83	97	11.59	
Chronic diseases					
Hypertension	574	17.03	91	15.85	<0.0001
Diabetes	264	7.83	41	15.53	0.0482
Malignancy	47	1.39	11	23.4	0.0012
Chronic lung disease	38	1.13	9	23.68	0.0002
Cardiovascular disease	80	2.37	18	22.5	<0.0001
Cerebrovascular disease	22	0.65	8	36.36	0.0039
Arthritis	252	7.48	56	22.22	<0.0001
Psychological disease	27	0.8	5	18.52	0.1694
Total	3,371	100	325	9.64	

Table 2. Health and behavioral factors influencing to early retirement due to health problem in all subjects

	Model 1		Model 2		Model 3	
	HR	95% CI	HR	95% CI	HR	95% CI
Demographics						
Age	—	—	1.060	(1.044–1.077)	1.051	(1.033–1.068)
Gender	—	—	1.735	(1.370–2.198)	1.842	(1.449–2.340)
Occupation	—	—	—	—	1.178	(1.094–1.269)
Pension income	—	—	—	—	0.887	(0.787–0.999)
Perceived health status						
Very good	1.00	Reference	1.00	Reference	1.00	Reference
Good	2.20	(0.97–4.99)	1.94	(0.85–4.40)	1.93	(0.85–4.38)
Moderate	3.52	(1.55–8.03)	2.51	(1.10–5.74)	2.49	(1.09–5.70)
Poor	7.11	(3.09–16.35)	4.14	(1.78–9.60)	4.01	(1.73–9.32)
Very poor	18.75	(7.39–47.56)	7.48	(2.88–19.40)	7.50	(2.89–19.43)
Health behaviors						
Smoking						
Nonsmoker	1.00	Reference	1.00	Reference	1.00	Reference
Ex-smoker	0.95	(0.67–1.35)	1.49	(0.98–2.26)	1.47	(0.97–2.23)
Current smoker	0.87	(0.68–1.12)	1.53	(1.11–2.10)	1.53	(1.11–2.10)
Problem drinking	0.67	(0.52–0.88)	0.86	(0.65–1.14)	0.88	(0.66–1.16)
Lack of exercise	1.36	(1.07–1.73)	1.12	(0.88–1.43)	1.15	(0.90–1.47)
BMI						
Normal or underweight	1.00	Reference	1.00	Reference	1.00	Reference
Overweight	1.29	(0.99–1.69)	1.12	(0.85–1.46)	1.12	(0.86–1.47)
Obese	0.98	(0.75–1.28)	1.35	(1.03–1.76)	1.36	(1.04–1.78)
Disease diagnosed						
Hypertension	2.00	(1.56–2.57)	1.51	(1.17–1.94)	1.51	(1.17–1.95)
Diabetes	1.78	(1.27–2.49)	1.49	(1.06–2.09)	1.47	(1.05–2.06)
Malignancy	2.78	(1.52–5.08)	1.98	(1.08–3.62)	1.95	(1.06–3.58)
Chronic lung disease	2.97	(1.53–5.77)	1.87	(0.96–3.66)	1.72	(0.88–3.36)
Cardiovascular disease	2.71	(1.69–4.37)	2.16	(1.34–3.49)	2.17	(1.35–3.51)
Cerebrovascular disease	3.19	(0.45–22.70)	2.50	(1.23–5.08)	2.22	(1.09–4.52)
Arthritis	2.86	(2.14–3.82)	1.55	(1.13–2.13)	1.59	(1.16–2.18)
Psychological disease	2.41	(0.99–5.82)	1.71	(0.70–4.15)	1.63	(0.67–3.98)

Model 1 is not adjusted. Model 2 is adjusted for age and gender. Model 3 is adjusted for age, gender, pension income and occupation.

ders, arthritis accounts for 70% of early retirement cases[18]. Respiratory symptoms, such as shortness of breath, are also reported as risk factors for early retirement[19]. Recently, a systemic meta-analysis[20] showed that the pooled relative risks (95% CI) of early retirement were 1.10 (0.99–1.21) for chronic disease, but the authors of that study did not elucidate the effect of particular chronic diseases, such as cardio-and cerebrovascular diseases. Our results enhance this evidence, as we show that hypertension, diabetes, arthritis, cardiovascular and cerebrovascular diseases, and malignancy are related to the risk of early retirement.

Although there were no significant associations between psychological diseases and the risk of ERdHP, psychological diseases in men showed the highest HR. Because there were only 27 workers who suffered psychological diseases in the current study, it is unclear whether psychological disease affects risk of ERdHP. Future studies with an increased sample size are needed to better elucidate this. Work-related psychological stress also increases the risk of retirement; thus, workers who suffer from psychological diseases are more vulnerable to early retirement[21]. A prospective study suggested that depression is also related to early retirement[22]. Moreover, a dose-response relationship was observed between depression scores and early retirement due to disability, other mental illness, cardiovascular illness, musculoskeletal illness, and non-illness stressors[22].

Table 3. Health and behavioral factors influencing to early retirement due to health problems in male subjects

	Model 1		Model 2		Model 3	
	HR	95% CI	HR	95% CI	HR	95% CI
Demographics						
Age	—	—	1.083	(1.060–1.106)	1.072	(1.048–1.097)
Occupation	—	—	—	—	1.259	(1.134–1.398)
Pension income	—	—	—	—	0.916	(0.799–1.052)
Perceived health status						
Very good	1.00	Reference	1.00	Reference	1.00	Reference
Good	1.51	(0.66–3.48)	1.27	(0.55–2.93)	1.21	(0.53–2.79)
Moderate	2.63	(1.14–6.09)	1.73	(0.74–4.04)	1.69	(0.73–3.95)
Poor	4.30	(1.78–10.39)	2.58	(1.06–6.28)	2.39	(0.98–5.83)
Very poor	12.44	(3.80–40.78)	5.08	(1.52–16.95)	4.31	(1.29–14.40)
Health behaviors						
Smoking						
Nonsmoker	1.00	Reference	1.00	Reference	1.00	Reference
Ex-smoker	1.61	(1.05–2.45)	1.44	(0.94–2.19)	1.42	(0.93–2.17)
Current smoker	1.37	(0.97–1.94)	1.48	(1.05–2.10)	1.48	(1.05–2.10)
Problem drinking	0.79	(0.57–1.08)	0.81	(0.59–1.11)	0.83	(0.60–1.14)
Lack of exercise	1.34	(0.99–1.83)	1.16	(0.85–1.59)	1.23	(0.89–1.70)
BMI						
Normal or underweight	1.00	Reference	1.00	Reference	1.00	Reference
Overweight	1.07	(0.74–1.56)	1.12	(0.79–1.59)	1.12	(0.79–1.59)
Obese	0.95	(0.67–1.35)	1.25	(0.85–1.81)	1.30	(0.89–1.89)
Disease diagnosed						
Hypertension	1.98	(1.42–2.77)	1.46	(1.04–2.05)	1.49	(1.06–2.09)
Diabetes	1.81	(1.02–3.21)	1.55	(1.02–2.35)	1.52	(0.99–2.31)
Malignancy	3.81	(1.78–8.15)	1.11	(0.41–3.01)	1.13	(0.42–3.08)
Chronic lung disease	1.69	(0.42–6.81)	2.46	(1.15–5.28)	2.10	(0.98–4.52)
Cardiovascular disease	2.90	(1.58–5.35)	2.20	(1.19–4.06)	2.26	(1.22–4.19)
Cerebrovascular disease	4.92	(2.18–11.11)	2.90	(1.27–6.59)	2.52	(1.11–5.75)
Arthritis	2.01	(1.38–2.93)	2.01	(1.22–3.30)	2.13	(1.29–3.52)
Psychological disease	5.32	(1.32–21.42)	4.21	(1.04–16.99)	2.93	(0.72–11.98)

Model 1 is not adjusted. Model 2 is adjusted for age and gender. Model 3 is adjusted for age, gender, pension income and occupation.

Overall, further research is needed to elucidate the association between psychological diseases and the risk of ERdHP.

Previous studies have revealed that perceived good health stimulates workers to sustain their job for a longer period[23]. Perceived poor health is related to increased mortality, future disability, future unhealthy activity, and depression[24]. Some studies suggest that perceived health might be an indicator of early retirement[25]. Our results support this evidence as we found a dose-dependent relationship between perceived health status and risk of ERdHP. Individuals with very poor perceived health status had an approximately 7.5 times higher risk of ERdHP compared to those with very good perceived health status.

In a prospective multinational study, unhealthy behavior was suggested to be an important target to reduce involuntary retirement in elderly workers[5]. Smoking is the most well known risk factor for various health conditions, and our study shows that cigarette smoking is also a risk factor for ERdHP. A recent well-designed cohort study collected male twin data to elucidate the long-term association between smoking and lifetime labor outcomes[26]. In that cohort, smoking was negatively associated with lifetime income level and number of employment years. Some cohort studies have reported a positive dose-response relationship between smoking and risk of ERdHP after controlling for covariates such as age, occupation, nationality, obesity, alcohol consumption, and accessibility to health care[27].

It is well known that 30 min or more of moderate-

Table 4. Health and behavioral factors influencing to early retirement due to health problems in female subjects

	Model 1		Model 2		Model 3	
	HR	95% CI	HR	95% CI	HR	95% CI
Demographics						
Age	—	—	1.035	(1.011–1.060)	1.030	(1.006–1.056)
Occupation	—	—	—	—	1.102	(0.987–1.231)
Pension income	—	—	—	—	0.918	(0.715–1.177)
Perceived health status						
Very good						
Good	1.00	Reference*	1.00	Reference*	1.00	Reference*
Moderate	1.29	(0.83–1.99)	1.16	(0.75–1.80)	1.14	(0.73–1.77)
Poor	2.80	(1.84–4.27)	2.26	(1.45–3.52)	2.23	(1.43–3.50)
Very poor	6.32	(3.33–12.02)	4.26	(2.14–8.49)	4.47	(2.23–8.97)
Health behaviors						
Smoking						
Nonsmoker	1.00	Reference	1.00	Reference	1.00	Reference
Ex-smoker						
Current smoker	2.22	(1.09–4.53)	1.97	(0.96–4.03)	1.95	(0.95–4.00)
Problem drinking	0.95	(0.53–1.72)	1.05	(0.58–1.90)	1.05	(0.58–1.91)
Lack of exercise	1.18	(0.81–1.71)	1.06	(0.73–1.54)	1.05	(0.72–1.54)
BMI						
Normal or underweight	1.00	Reference	1.00	Reference	1.00	Reference
Overweight	1.74	(1.18–2.57)	1.15	(0.76–1.75)	1.14	(0.74–1.74)
Obese	1.19	(0.78–1.81)	1.56	(1.06–2.31)	1.53	(1.03–2.26)
Disease diagnosed						
Hypertension	2.03	(1.40–2.94)	1.59	(1.08–2.34)	1.61	(1.09–2.37)
Diabetes	1.81	(1.02–3.21)	1.41	(0.79–2.51)	1.40	(0.79–2.49)
Malignancy	3.81	(1.78–8.15)	3.25	(1.51–6.97)	3.21	(1.49–6.92)
Chronic lung disease	1.69	(0.42–6.81)	1.07	(0.26–4.35)	1.02	(0.25–4.18)
Cardiovascular disease	2.52	(1.18–5.39)	2.06	(0.96–4.42)	2.12	(0.98–4.59)
Cerebrovascular disease	3.02	(0.75–12.21)	1.77	(0.43–7.23)	1.63	(0.39–6.75)
Arthritis	2.01	(1.38–2.93)	1.47	(0.98–2.19)	1.48	(0.99–2.21)
Psychological disease	1.25	(0.40–3.92)	1.21	(0.39–3.81)	1.22	(0.39–3.87)

Model 1 is not adjusted. Model 2 is adjusted for age and gender. Model 3 is adjusted for age, gender, pension income and occupation. *Because female workers who perceived their health to be "very good" did not experienced unwanted early retirement, we set the reference group as "moderate".

intense physical activity can prevent chronic disease including cardiovascular and cerebrovascular diseases, osteoporosis, and depression[28]. These chronic diseases reduce the sustainable working status in those with good health and contribute to early retirement. There is strong evidence from the Worksite Physical Activity Programs (WPAP) that an increase in workers' physical activity and general health is linked to a reduction in musculoskeletal disorders[29]. Because musculoskeletal disorders are one of the most common problems in the workplace that contribute to a reduced sustainable working status, preventing these disorders could help workers to sustain their jobs[30] or find other jobs, hence sustaining their working status following involuntary retirement. Furthermore, because poor cardiorespiratory fitness increases the risk of ERdHP[31], improving physical activity could protect workers from ERdHP risk. Our study revealed a marginal association between lack of physical activity and ERdHP risk. However, in the current study, arthritis predicted risk of ERdHP. Since arthritis can be prevented by physical activity, future research should be directed towards clarifying the impact of physical activity on ERdHP risk.

Alcohol-related health problems increase social costs by a direct pathway and indirect pathways, including sickness, work absence, and early retirement[32]. A study from Finland reported that all types of drinking—including binge drinking, heavy average drinking, and all types of problem drinking—

were associated with work absence due to sickness[33]. These significant associations remain after adjusting for working condition. In a 39-year follow-up study, problem drinking in adolescence increased the risk of retirement due to disability pension[34]. Contrary to earlier findings, however, no evidence of a relationship between problem drinking and risk of ERdHP was detected in the current study, but these results should be interpreted with caution, because we could not calculate the exact amount of alcohol consumption due to lack of detailed information such as grams of alcohol consumed or kinds of glass used.

In general, manual workers endure heavy physical work compared with other occupations. Some studies suggest that forced muscular loading and uncomfortable work positions are related to early retirement due to musculoskeletal disorders[31]. This supports our result that retirement rates exceed 40% in manual workers, which is almost 2.5 times higher than that in managers and professionals (Table 1). Furthermore, sales and service workers show approximately 2 times the retirement rate than managers and professionals. This may be due to their requirements to respond to customers complaints, and express organizationally desired emotions while concealing other emotions in order to maintain economically positive relationships with customers (i.e., "emotional labor")[35]. These standardized emotions can cause depersonalization, emotional exhaustion, burnout, and depression[36]. These conditions are linked to psychological disease, which increases the risk for early retirement[22].

In the current study, smoking status was related to the risk of ERdHP in men, but not in women (Tables 3 and 4). This gender difference has been reported in previous studies showing that smoking increases the risk of early retirement in men, but not in women[14]. In the current study, obesity was linked to the risk of ERdHP in women, but not in men. Overall, however, the effect of gender on obesity in relation to early retirement has not been well studied. Some studies have shown that gender and race are associated with obesity and risk of early retirement. In particular, obesity has been shown to increase the risk of early retirement in African-American women and white men, but not in African-American men and white women[37]. In the current study, malignancy was linked to the risk of ERdHP in women but not in men. Contrary to that, the presence of arthritis and cardiovascular and cerebrovascular diseases increased the risk of ERdHP in men, but not in women. The reason for these gender differences is not known; hence, further research aimed at elucidating this is needed.

There are several limitations in the current study. Some articles suggest the severity of illnesses are strong predictors of early retirement; furthermore, long-term illness is independently linked to self-perceived health status[6]. However, because the severity of illness was not collected in the current study, we did not incorporate the severity of each chronic disease in the current study. Some studies indicate that work demands, work stress[38], decision authority[39], and a misfit between work demands and health status are risk factors for early retirement[40]. For example, heavy physical work load is related to early retirement due to musculoskeletal disorder, not early retirement due to mental diseases[31]. However, we did not control for these factors. We used self-reported questionnaires to identify subjects' chronic diseases and unhealthy behavior. Nevertheless, some studies using subjective and objective methods have tended to give reasonably consistent results[41]. In addition, the follow-up period in the current study is relatively short (i.e., 8 years) compared with other studies. Hence, further study with extended follow-up periods is encouraged.

In conclusion, we conducted this study to examine the influence of illness and unhealthy behavior on ERdHP. The presence of hypertension, diabetes, malignancy, arthritis, and cardiovascular and cerebrovascular diseases was shown to predict ERdHP risk. In particular, there was a dose-response relationship between perceived health status and risk of ERdHP. Unhealthy behavior and characteristics, including cigarette smoking and obesity, were also related to the risk of ERdHP. Furthermore, our results revealed gender differences in the risk of ERdHP. These results can inform the development of strategies for reducing risk of ERdHP, and for promoting sustainable labor in aging societies.

Conflict of interests: All the authors have approved the manuscript and agree with submission to your esteemed journal. There are no conflicts of interest to declare.

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