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Original Article

Age and Gender Differences in the Relation of Chronic Diseases to Activity of Daily Living (ADL) Disability for Elderly South Koreans: Based on Representative Data

Il-Ho Kim

Social Aetiology of Mental Illness (SAMI) CIHR Training Program,
Social Equity and Health Research Center for Addition and Mental Health, Toronto, Canada

Objectives: This study investigated the gender and age differential effect of major chronic diseases on activity of daily living (ADL) disability.
Methods: Surveyfreq and Surveylogistic regression analyses were employed on the 2005 Korean National Health and Nutrition Examination Survey (KNHANES) with a sample of 3,609 persons aged 65-89.
Results: After adjusting for potential covariates, stroke, among elderly men more so than women, had a 2-3 times greater odds of engendering ADL disability in the 65-69 ($p < 0.05$) and 70-79 age groups ($p < 0.01$). In comparison to elderly women, cancer, diabetes, and incontinence in elderly men was associated with a higher risk of ADL disability in the 70-79 age group ($p < 0.05$), and this association was also observed for pulmonary disease in the 80-89 age group. Among elderly women, however, a significant association between incontinence and ADL disability was identified in all three age groups. In addition, this association was found in pulmonary disease and diabetes in elderly women aged 70-79 years. Significant gender differences were observed in the association between stroke in the 60-79 age group and cancer in the 70-79 age group.
Conclusions: Age and gender differences were observed in the effect of chronic diseases on ADL disability.

Key words: Elderly, Gender, Chronic diseases, ADL disability
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INTRODUCTION

Alongside an increase in life expectancy and an explosive growth in the elderly population worldwide, chronic diseases, such as coronary heart disease, cancer, incontinence, pulmonary disease, and diabetes, have become well-known determinants for developing activity of daily living (ADL) disability [1]. Moreover, significant research has illustrated that the effect of chronic diseases on ADL disability varies by gender and increases dramatically for the more senior elderly [2-4]. According to the BRFSS (CDC) 2005 survey, around 30.7% of stroke survivors experience a permanent impairment of physical functioning [5]. A Swedish study suggested that in those aged 75 years or older, more than 50% of stroke survivors developed ADL disability [6]. Studies from the U.S. [7,8], Italy [9], and Finland [10] found similar results for urinary incontinence, pulmonary disease, arthritis, and diabetes. However, evidence also falls in line with a more controversial view. Research that used the Women's Health and Aging Study failed to prove any association between chronic diseases and ADL disability in elderly women [11]. Several studies suggested that the incidence of stroke was greater among elderly men than women, but elderly women who survived a stroke experienced a greater risk of developing ADL disability than elderly men [12,13]. In contrast, other studies argued that significant gender differences for stroke-induced disability was attributed to elderly women's higher incidence rate with increasing age [13,14]. Research from Italy illustrated that elderly men with incontinence were more likely to report a significant ADL disability than elderly women [9], but the opposite was found in a Finnish study [10]. Recent evidence has shown that the disability that elderly men and women live with can be reversed by modifying the severity of chronic diseases [15]. Perhaps these confusing findings partly underline a methodological weakness because many studies treated gender or age as confounding variables. In addition, the majority of

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Corresponding author : Il-Ho Kim, MD, PhD
455 Spadina Avenue, Suit 300, Toronto, Ontario, M5S 2G8, Canada
Tel : +01-416-535-8501, Fax: +01-416-979-6811, E-mail : il-ho_kim@camh.net
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studies in this area have failed to consider the contribution of socioeconomic factors-factors that are known to increase the risk of chronic-disease and disability. More importantly, research on this issue has been conducted almost exclusively in Western countries and hardly at all in Asia.

Population aging is a global phenomenon, and South Korea is one of the fastest aging societies. The elderly, who made up 9.9% of the population in 2007, will increase to 14.3% of the population by 2018 [16]. In 2007, 78% of the elderly had at least one chronic disease, and apparently 42% were living with a physical limitation [17]. Unlike other developed countries, the prevalence of chronic diseases in South Korean has increased continuously. Medical expenses also have increased by 25% from 1995 to 2000 [18]. Additionally, elderly women have experienced a higher risk of chronic diseases than their male counterparts [17,19]. Understanding chronic diseases' age and gender differential effect on the development of ADL disability is a crucial priority for public-health policy making, such as long-term care planning and future medical-care spending. In the South Korean context, however, studies have been very limited. To bridge the knowledge gap between Western and Asian countries, this study's first aim was to examine the gender-specific prevalence of chronic diseases and ADL disability among South Korean elderly. Its second aim was to investigate whether specific chronic diseases were associated with ADL disability according to gender and age. Our analysis used data from a representative sample of elderly South Koreans.

MATERIALS AND METHODS

I. Design and Study Population

Data were collected from the 2005 Korean National Health and Nutrition Examination Survey (KNHANES) conducted by the Korean Ministry of Health and Welfare. This survey applied a stratified multistage probability sampling design on the South Korean population. Using two-stage stratified systematic sampling methods, 600 national districts were selected from 246 097 Census survey districts. Clusters of households were chosen systematically. Each district included an average of 22 households. This Health Interview Survey sampled 13 200 households from the 600 districts. From these households, 40 000 household members participated in the 2005 KNHANES. The 2005 KNHANES employed three questionnaires: the Health Interview Survey, the Health Behavior Survey, and the Nutrition Survey. This study's variables were derived from the Health Interview Survey. The response rate was 92.6%. From the total survey population of 34 152 (16 360 men and 17 792 women), individuals who were disabled from birth were excluded from the analysis (33 men and 31 women). This study selected 3658 persons aged 65-89 years (1487 men and 2198 women). The survey's missing values were less than 2% (49 individuals). Thus, the analysis used a population sample of 3609 participants: 1453 men and 2156 women aged 65-89 years. The sample weights in the 2005 KNHANES reflected a stratified clustering probability sampling design. In order to calculate appropriate estimates and standard errors, this study's final sample was determined by using the sample weights in the 2005 KNHANES.

II. Chronic Disease

Chronic conditions: The 2005 KNHANES surveyed only major chronic diseases by asking respondents questions such as: "Have you experienced any chronic diseases during the past year?" The survey, moreover, sought to include only physician-diagnosed cases, so respondents were asked: "Was the chronic disease diagnosed by a physician?" "Chronic diseases" were defined as diseases lasting at least three months in the preceding 12 months. Based on previous research, fourteen categories of major chronic diseases, in accordance with The International Classification of Diseases, 10th Revision Clinical Modification (ICD-10-CM), were selected for this study, and these groups were: 1) cancer (stomach (C16), liver (C22), lung or bronchial (C34), colon (C17-C20), breast (C50), and cervical cancer (C51-C55)); 2) arthritis (M05-M09, M11-M13, M15-M19); 3) osteoporoses (M80-M85); 4) disk disorder (M50-51); 5) liver disease (cirrhosis (K74), hepatitis (K73)); 6) stomach ulcer (K25-K29); 7) hypertension (I10-I15); 8) hyperlipidemia (I70); 9) stroke (I60-I69); 10) coronary heart disease (I20, I23-I25); 11) pulmonary disease (asthma (J45), chronic obstructive pulmonary disease (J40-44), chronic sinusitis (J32), bronchiectasis (J47); 12) diabetes (E10-E14); 13) anemia (E50-E64); and 14) incontinence (N39.3, N39.4, R32). Respondents who reported having taken medication for any of these conditions were included in this category.

III. Disability

The main dependent variable was an ability to perform ADLs recently for a period of one week. Disability was

Table 1. Weighted percentage of demographic among the elderly, aged 65-89 years (N=3609), stratified by gender and ADL disability, the 2005 Korean National Health and Nutrition Examination Survey (KNHANES)

Characteristics	Men			p^1	Women			p^1
	Un-weighted population	Weighted population			Un-weighted population	Weighted population		
		Non-disability	Disability n (%)			Non-disability	Disability n (%)	
Age (y)	1453				2156			
65 - 69	673 (43.9)	692 897 (92.8)	53 930 (7.2)	<0.001	819 (35.9)	808 644 (88.6)	103 554 (11.4)	<0.001
70 - 74	417 (29.4)	442 548 (88.5)	57 289 (11.5)		610 (28.7)	622 246 (85.2)	107 793 (14.8)	
75 - 79	205 (15.1)	195 146 (76.2)	61 080 (23.8)		425 (20.6)	386 087 (73.8)	137 048 (26.2)	
80 - 84	117 (8.7)	110 955 (75.3)	36 398 (24.7)		211 (10.5)	178 665 (66.9)	88 544 (33.1)	
85 - 89	41 (3.0)	31 316 (61.1)	19 936 (38.9)		91 (4.3)	52 858 (47.9)	57 532 (52.1)	
Education								
High school or more	451 (31.8)	496 003 (91.7)	44 661 (8.3)	<0.001	144 (6.6)	152 272 (90.9)	16 275 (9.1)	<0.001
Elementary school or more	787 (53.6)	785 357 (86.2)	125 857 (13.8)		972 (43.5)	955 384 (84.5)	175 272 (15.5)	
Less than elementary	215 (14.6)	191 503 (76.7)	58 116 (23.3)		1040 (48.9)	940 844 (75.6)	303 925 (24.4)	
Household income[2]								
Q3 (high)	477 (32.4)	506 471 (92.0)	44 276 (8.0)	<0.001	706 (32.2)	656 994 (80.1)	162 848 (19.9)	0.34
Q2 (middle)	493 (34.5)	495 966 (84.4)	91 401 (15.6)		637 (30.1)	632 281 (82.6)	133 186 (17.4)	
Q1 (low)	483 (33.1)	470 426 (83.5)	92 956 (16.5)		813 (37.7)	759 224 (79.3)	198 437 (20.7)	
Marital status								
Married	1293 (88.3)	1 296 014 (86.3)	205 797 (13.7)	0.420	807 (36.4)	790 146 (85.3)	136 321 (14.7)	<0.001
Single, Widowed, Divorced, Separated	159 (11.7)	175 434 (88.5)	22 836 (11.5)		1349 (63.6)	1 258 354 (77.8)	358 150 (22.2)	

[1]Chi-square tests were conducted to calculate *p*-value.
[2]Monthly household income divided by the square root of the number of people in the household.
The household equivalence income was categorized as tertiles (high, middle, low).

defined as having difficulty or partial difficulty with one or more of the following seven basic ADLs: dressing, washing hands and face, bathing, toileting, eating, ambulating in and out of a bed, and maintaining control of bowel and/or bladder functions. A dichotomous variable (no ADL disability/at least one ADL disability in a category) was generated. ADLs were measured using the Korean ADL (K-ADL) scale [20], which was developed to measure accurately the functioning of South Korean elderly. The K-ADL has been judged a very reliable tool for quantifying elderly functioning, and thus it has wide usage.

IV. Covariates

Covariates included age, marital status, and socioeconomic position (education or an equivalent monthly household income). Marital status was divided into two groups: married or single/widowed/divorced/separated. Educational levels included high school or more, elementary school or more, or less than elementary. Household equivalent income (=total household income per family size 0.5) was grouped into tertiles.

V. Statistical Methods

All the analyses were stratified by gender and into three age groups (65-69, 70-79, and 80-89). Since this sample was collected by a stratified clustering multistage probability method, survey freq and survey logistic procedures were applied to estimate parameters and odds ratios as a maximum likelihood method. A survey freq test was used to estimate the weighted percentage of demographic variables. The age-sex standardized prevalence of chronic diseases was calculated with an age adjustment for 1-year age groups, using a direct method. In order to estimate the age-sex standardized prevalence and confidence intervals, the distribution of all samples was used as a reference. A survey logistic procedure, which fits multiple logistic regression models, was applied in this analysis. This analysis estimated the odds ratio (OR) and the 95 percent confidence intervals (95% CI), after adjusting for age, educational qualification (less than elementary, elementary or more, high school or more), household income (low, middle, high), marital status, and other chronic diseases. Significant tests were performed to determine gender differences in the relationships between diseases and ADL. All analyses used SAS statistical version 9.2 (SAS Inc., Cary, NC, USA).

RESULTS

Table I showed socio-demographic characteristics according to gender and ADL disability stratification.

Table 2. Age-sex standardized prevalence[1] (and 95% confidence intervals) of ADL disability and chronic diseases diagnosed by a physician among the elderly, aged 65-89 years (N=3609)[2] and stratified by gender and age, the 2005 Korean National Health and Nutrition Examination Survey (KNHANES)

	All (65 - 89)		65 - 69	
	Men	Women	Men	Women
Disability (ADL)	13.3 (11.5 - 15.2)***	20.8 (18.9 - 22.7)***	7.5 (7.0 - 8.0)**	12.2 (11.6 - 12.8)**
p for trend				
CHRONIC DISEASE				
Cancer[3]	4.4 (3.3 - 5.4)***	1.6 (1.1 - 2.1)***	4.0 (2.5 - 5.5)*	2.7 (2.4 - 3.1)*
Arthritis	29.7 (26.9 - 32.5)***	64.7 (61.4 - 68.1)***	22.6 (22.1 - 23.8)***	67.9 (66.4 - 69.5)***
Osteoporosis	3.3 (2.3 - 4.2)***	27.6 (25.4 - 29.8)***	3.3 (2.9 - 3.7)***	32.1 (31.0 - 33.1)***
Disk	9.7 (8.1 - 11.2)***	14.3 (12.7 - 15.8)***	12.4 (11.8 - 13.0)*	16.5 (15.7 - 17.3)*
Liver[4]	1.6 (0.9 - 2.2)**	0.8 (0.4 - 1.2)**	2.1 (1.8 - 2.4)	3.4 (3.1 - 3.8)
Peptic ulcer	4.3 (3.2 - 5.3)	4.1 (3.2 - 4.9)	3.6 (2.1 - 5.0)	4.9 (4.6 - 5.4)
Hypertension	36.2 (33.1 - 39.3)***	45.6 (42.8 - 48.4)***	36.3 (35.2 - 37.4)*	50.2 (48.9 - 51.5)*
Hyperlipidemia	2.8 (1.9 - 3.6)**	4.9 (4.0 - 5.8)**	4.8 (4.4 - 5.2)*	7.2 (6.7 - 7.7)*
Stroke	6.9 (5.6 - 8.3)	5.5 (4.5 - 6.5)	4.9(3.2 - 6.5)*	7.3 (6.7 - 7.7)*
Coronary heart disease[5]	5.9 (4.7 - 7.2)	6.3 (5.2 - 7.3)	5.7 (5.2 - 6.1)	4.1 (3.7 - 4.4)
Pulmonary[6]	16.9 (14.8 -19.0)**	13.9 (12.3 - 15.4)**	24.6 (23.7 - 25.5)	14.3 (13.5 - 15.0)
Diabetes	15.4 (13.4 - 17.4)	15.7 (14.1 - 17.4)	14.5 (13.8 - 15.2)	14.9 (14.2 - 15.6)
Anemia	6.7 (5.3 - 8.0)***	15.4 (13.8 - 17.1)***	7.2 (6.7 - 7.7)***	18.4 (17.6 - 19.2)***
Incontinence	4.6 (3.5 - 5.6)***	44.6 (41.8 - 47.4)***	3.4 (3.0 - 3.7)***	55.3 (54.0 - 56.7)***

Table 2. Continued

	70 - 79		80 - 89	
	Men	Women	Men	Women
Disability (ADL)	15.5 (12.5 - 18.5)*	19.2 (16.5 - 21.9)*	27.0 (18.9 - 35.1)**	39.5 (32.9 - 46.1)**
p for trend			< 0.0001	< 0.0001
CHRONIC DISEASE				
Cancer[3]	4.7 (3.0 - 6.4)***	1.5 (0.7 - 2.2)***	4.9 (1.4 - 8.4)***	0.3 (0.0 - 0.9)***
Arthritis	32.4 (28.0 - 36.7)***	67.1 (62.1 - 72.2)***	41.8 (31.7 - 51.8)***	64.2 (55.8 - 72.6)***
Osteoporosis	2.3 (1.1 - 3.4)***	28.4 (25.2 - 31.8)***	6.7 (2.7 - 10.9)***	24.4 (19.3 - 29.6)***
Disk	9.4 (7.1 - 11.8)***	15.0 (12.7 - 11.8)***	10.4 (5.5 - 15.4)	12.8 (9.0 - 16.5)
Liver[4]	2.2 (0.9 - 3.3)***	0.3 (0.01 - 0.6)***	0.6 (0.1 - 1.2)	NS
Peptic ulcer	5.4 (3.6 - 7.3)	4.1 (2.9 - 5.4)	0.6 (0.01 - 2.0)*	2.69 (1.57 - 6.03)*
Hypertension	37.5 (32.6 - 42.2)***	49.2 (44.9 - 53.6)***	30.7 (22.1 - 39.3)**	44.6 (37.6 - 51.6)**
Hyperlipidemia	1.9 (0.9 - 3.1)**	4.4 (3.1 - 5.7)**	2.5 (0.4 - 4.8)	2.0 (0.5 - 3.5)
Stroke	9.1(6.8 - 11.4)***	5.1 (3.7 - 6.5)***	6.1 (2.3 - 10.0)	3.4 (1.4 - 5.4)
Coronary heart disease[5]	8.2 (6.0 - 10.4)	7.8 (6.0 - 9.5)	4.3 (1.0 - 7.5)	3.4 (1.4 - 5.4)
Pulmonary[6]	17.0 (13.9 - 20.2)	14.4 (12.1 - 16.8)	20.9 (13.8 - 27.9)*	12.5 (8.7 - 16.2)*
Diabetes	15.0 (12.1 - 18.0)	17.8 (15.2 - 20.4)	11.1 (5.9 - 16.2)	11.3 (7.8 - 14.9)
Anemia	6.5 (4.5 - 8.5)***	15.6 (13.21 - 18.1)***	8.0 (3.6 - 12.3)**	16.5 (12.2 - 20.8)**
Incontinence	5.9 (4.0 - 7.8)***	45.3 (41.2 - 49.4)***	4.9 (1.4 - 8.4)***	48.8 (41.6 - 56.2)***

NS: not shown.

[1]Age-sex standardized prevalence (and 95% CI) of chronic diseases were calculated with age adjustment to 1-year age according to the direct method with the distribution of total sample as reference.

[2]Weighted sample of the elderly aged 65-89 years old, stratified by gender and age from the 2005 Korean National Health and Nutrition Examination Survey (KNHANES).

[3]Cancer included stomach, liver, lung or bronchial, colon, breast, and cervical cancers.

[4]Liver diseases included cirrhosis, hepatitis.

[5]Coronary heart disease included angina pectoris, myocardial infarction.

[6]Pulmonary diseases included asthma, chronic obstructive pulmonary disease, chronic sinusitis, and bronchiectasis.

Gender differences were tested with a Rao-Scott chi-square test: *p < 0.05, **p < 0.01, ***p < 0.001.

The result indicated that the proportion of ADL disability increased with age: the oldest being the most disabled. Less educated elderly men and women appeared to have more disability than their educated counterparts (men 8.3% vs. 23.3%; women 9.1% vs. 24.4%, respectively). However, a higher proportion of disability was observed among elderly men with low incomes than among those with high incomes. In contrast, elderly women who are single, widowed, divorced, or separated were more likely to have a higher proportion of disability when compared with married elderly men (22.2% vs. 14.7%).

Table 3. Adjusted odds ratios[1] (and 95% Confidence Intervals) for ADL disability, according to chronic disease diagnosed by a physician, aged 65-89 years (N=3609)[2], stratified by gender and age, the 2005 Korean National Health and Nutrition Examination Survey (KNHANES)

	All (65 - 89)		65 - 69	
	Men	Women	Men	Women
Chronic disease				
Cancer[3]	2.67 (1.30 - 5.48)*	0.85 (0.27 - 2.73)*	2.13 (0.59 - 7.76)	0.74 (0.07 - 7.40)
Arthritis	1.38 (0.93 - 2.05)	1.13 (0.86 - 1.49)	0.88 (0.28 - 2.78)	0.58 (0.29 - 1.14)
Osteoporosis	1.34 (0.51 - 3.50)	1.18 (0.87 - 1.61)	0.32 (0.02 - 5.31)	0.88 (0.47 - 1.65)
Disk	1.24 (0.61 - 2.50)	0.89 (0.59 - 1.35)	0.57 (0.17 - 1.93)	0.96 (0.46 - 2.02)
Liver[4]	1.42 (0.37 - 5.43)	0.12 (0.01 - 1.88)	0.54 (0.06 - 4.96)	0.24 (0.02 - 2.99)
Peptic ulcer	0.51 (0.18 - 1.51)	1.08 (0.62 - 1.90)	NS	1.66 (0.65 - 4.26)
Hypertension	0.61 (0.41 - 0.83)	1.19 (0.92 - 1.52)	0.36 (0.14 - 1.03)	1.47 (0.83 - 2.63)
Hyperlipidemia	1.61 (0.45 - 5.77)	0.67 (0.36 - 1.23)	0.45 (0.02 - 11.70)	0.46 (0.15 - 1.38)
Stroke	18.56 (10.51 - 32.76)**	7.48 (4.40 - 11.13)**	15.54 (4.75 - 50.85)*	7.76 (3.46 - 17.40)*
Coronary heart disease[5]	1.10 (0.56 - 2.17)	0.96 (0.54 - 1.55)	0.77 (0.18 - 3.28	0.22 (0.04 - 1.18)
Pulmonary[6]	1.53 (0.96 - 2.45)	1.66 (1.20 - 2.30)	0.43 (0.12 - 1.48)	0.69 (0.33 - 1.42)
Diabetes	1.73 (1.00 - 3.00)	1.43 (1.00 - 2.04)	0.90 (0.26 - 3.12)	0.88 (0.45 - 1.73)
Anemia	0.82 (0.37 - 1.83)	1.32 (0.96 - 1.84)	0.65 (0.15 - 2.76)	1.06 (0.53 - 2.11)
Incontinence	3.55 (1.76 - 7.18)	2.92 (2.23 - 3.85)	2.54 (0.56 - 11.59)	2.57 (1.41 - 4.68)

Table 3. Continued

	70 - 79		80 - 89	
	Men	Women	Men	Women
Chronic disease				
Cancer[3]	3.59 (1.30 - 9.87)*	0.55 (0.09 - 3.45)*	0.67 (0.11 - 4.03)	NS
Arthritis	1.15 (0.63 - 2.11)	1.35 (0.91 - 2.02)	1.69 (0.46 - 6.24)	1.49 (0.71 - 3.09)
Osteoporosis	0.86 (0.10 - 7.58)	1.14 (0.74 - 1.75)	7.32 (0.91 - 58.86)	1.05 (0.47 - 2.36)
Disk	1.17 (0.41 - 3.37)	1.02 (0.60 - 1.75)	5.07 (0.98 - 26.26)	0.54 (0.18 - 1.60)
Liver[4]	1.42 (0.19 - 10.74)	NS	NS	NS
Peptic ulcer	0.86 (0.25 - 2.91)	0.90 (0.43 - 1.90)	0.11 (0.01 - 1.76)	1.77 (0.45 - 6.99)
Hypertension	0.57 (0.33 - 1.03)	1.05 (0.74 - 1.49)	0.52 (0.16 - 1.73)	1.23 (0.57 - 2.65)
Hyperlipidemia	1.94 (0.27 - 13.89)	0.45 (0.15 - 1.30)	4.75 (0.50 - 45.43)	3.82 (0.58 - 25.25
Stroke	23.05 (11.31 - 46.98)**	5.93 (2.96 - 11.90)**	12.02 (1.41 - 54.53)	21.20 (2.56 - 155.1)
Coronary heart disease[5]	0.93 (0.37 - 2.32)	1.32 (0.71 - 2.47)	0.83 (0.12 - 6.01)	1.87 (0.31 - 11.08)
Pulmonary[6]	1.89 (0.98 - 3.63)	2.16 (1.32 - 3.55)	5.38 (1.17 - 24.75)	1.77 (0.79 - 3.96)
Diabetes	2.55 (1.28 - 5.10)	1.75 (1.10 - 2.80)	0.26 (0.04 - 1.65)	1.00 (0.39 - 2.54)
Anemia	0.66 (0.19 - 2.35)	1.38 (0.87 - 2.21)	0.43 (0.09 - 1.99)	1.64 (0.71 - 3.79)
Incontinence	4.56 (2.15 - 9.71)	3.08 (2.07 - 4.59)	2.96 (0.40 - 21.84)	2.56 (1.33 - 4.92)

NS: not shown.
[1]Odds ratio (and 95%CI) were calculated using multiple logistic regression analysis after adjusting for age, educational qualification (less than elementary, elementary or more, high school or more), household income (low, middle, high), marital status (married, widowed/divorced/separated), and other chronic diseases.
[2]Weighted sample of the elderly aged 65-89 years old, stratified by gender and age from the 2005 Korean National Health and Nutrition Examination Survey (KNHANES).
[3]Cancer included stomach, liver, lung or bronchial, colon, breast, and cervical cancers.
[4]Liver diseases included cirrhosis, hepatitis.
[5]Coronary heart disease included angina pectoris, myocardial infarction.
[6]Pulmonary diseases included asthma, chronic obstructive pulmonary disease, chronic sinusitis, and bronchiectasis.
Gender differences in chronic disease risk were tested by adding gender interaction terms between gender and chronic diseases into the model:
*$p < 0.05$, **$p < 0.01$.

Table 2 presented the age-sex standardized prevalence of self-reported chronic conditions, as diagnosed by a physician, after being stratified by gender and age. Gender- and age-differences in the prevalence of ADL disability and chronic diseases were observed. The prevalence of ADL disability was 13.3% for elderly men and 20.8% for elderly women. The prevalence of ADL disability increased considerably with age: the elderly aged 80 - 89 were the most disabled (men 27%, women 39.5%, p for trend < 0.0001 in both genders). A significantly higher prevalence of cancer, liver, and pulmonary diseases was observed among elderly men than women (cancer: 4.4% vs. 1.6%, liver: 1.6% vs. 0.8%, pulmonary: 16.9% vs. 13.9%). With a few exceptions, a notably higher prevalence of most chronic diseases was found among elderly women in

comparison to elderly men. Whereas the gender difference in the prevalence of chronic diseases increased overall in the 70-79 age group, the prevalence of stroke was significantly higher among elderly men than women in this age group ($p < 0.0001$). In addition, the trend, only among men, was toward an increase in stroke's prevalence with increasing age (p for trend = 0.021, data not shown). Although the prevalence of incontinence was more noticeable among women than men, a significantly higher increase in this trend was observed among both genders as they aged (p for tend = 0.007, 0.017, respectively, data not shown).

Table 3 illustrated the gender and age-differential effect of chronic diseases on ADL disability after stratifying elderly men and women into three age groups (65 - 69, 70 - 79, and 80 - 89). After adjusting for covariates, an association between specific diseases and ADL disability was detected in cancer, stroke, diabetes and incontinence among elderly men. Contrastingly, stroke, pulmonary disease, diabetes, and incontinence were significantly associated with ADL disability for elderly women. Although stroke was significantly associated with ADL disability in both genders, the odds of having ADL disability was 2 - 4 times greater among elderly men than women in the 65 - 69 and 70 - 79 age groups (OR, 15.54 vs. 7.76, $p < 0.05$; OR, 23.05 vs. 5.93, $p < 0.01$). In the 80-89 age group, the effect seemed to be reversed (OR, 12.02 vs. 21.2). In elderly men aged 70 - 79 years, cancer, diabetes, and incontinence were associated with ADL disability, and this association was also observed for pulmonary disease in the 80 - 89 age group. Conversely, elderly women with incontinence had a high risk of developing ADL disability in all age groups. Among elderly women aged 70 - 79 years, these associations appeared for diabetes and pulmonary diseases. Significant gender differences were observed in the association between ADL disability and stroke in the 65 - 79 age group and cancer in the 70 - 79 age group.

DISCUSSION

Results from this representative sample of elderly South Koreans suggested a significant gender and age difference in the magnitude of chronic diseases and their effect on ADL disability. Elderly women (20.8%) more than men (13.3%) suffered from a higher risk of ADL disability. The prevalence of ADL disability significantly increased with age (p for trend < 0.0001 in both genders). With a few exceptions, elderly women have a higher prevalence of chronic diseases than elderly men. After controlling for potential covariates, cancer, stroke, diabetes, and incontinence were strongly associated with a high risk of ADL disability among elderly men. These associations were found in stroke, pulmonary disease, diabetes, and incontinence among elderly women. After stratifying elderly men and women into the three age groups, significant gender differences in the association were found for stroke in the 65 - 79 ($p < 0.05$, $p < 0.01$), cancer in the 70 - 79 age group ($p < 0.05$).

The Prevalence of ADL Disability and Chronic Diseases

This finding of a higher prevalence of disability among elderly women than men was consistent with previous research [3,21]. Several empirical studies have attributed the cause of these high levels of women's ADL disability to a much lower recovery or mortality rate in comparison to elderly men [2,22]. In contrast to a commonly held belief, this study found no statistically significant differences for coronary heart disease and diabetes between elderly men and women. One Korean study suggested that 74% of men and 29% of women had more than one risk factor for cardiovascular disease, but the prevalence of risk factors for women in comparison to men became more even-handed after menopause [23].

In comparison to previous South Korean research, this study observed that elderly women had a higher prevalence of hypertension than elderly men (45.6% vs. 36.2%) [23]. This contradictory result might be explained by the previous study's use of subjective methods (self-rated hypertension) instead of more reliable objective measurements (gauging blood-pressure levels) to determine the presence of hypertension. Nonetheless, a further analysis by the author, using the Health Behavior Survey data, showed that the internal consistency of hypertension between objective and subjective measures was quite high (Cronbach's alpha, 0.719; data not shown). Although the analysis revealed a higher prevalence of hypertension when objective instead of subjective measures were used, the trend toward a higher prevalence of hypertension for men more so than women was apparently reversed when they reached the age of 70 or older (men 46.4% vs. women 63.2%) [18]. Whereas obesity, drinking, and smoking are well-established risk factors for developing hypertension, this study was unable to specify the reason for this reversed age-specific gender increase.

This study also found that stroke was more common in elderly women in the 65 - 69 age group (4.9% vs. 7.3%), but in the 70 - 79 age group, its prevalence was significantly higher among elderly men (9.1% vs. 5.1%). The risk factors for stroke-family history, hypertension, heavy alcohol drinking, active and passive smoking, high sodium intake, and the body mass index-are well known [24]. Quite possibly, the heavy alcohol and tobacco consumption of South Korean men could contribute to their higher risk of stroke when they reach 70 - 79 years of age. In contrast to evidence of coronary heart disease, menopause in women was unlikely to influence the higher risk for developing stroke [25]. However, this discrepancy in the age and gender trends between the prevalence of stroke and coronary heart disease needs to be explored.

In this study, the prevalence of incontinence between elderly women (44.6%) and men (4.6%) showed an extreme gender gap. Very different findings were observed from an Italian study (20.6% vs. 11.2%) [9] and a U.S. study (30% vs.15%) [26]. Be this as it may, the higher prevalence of incontinent among elderly women could be attributed to the rigors of childbearing while the physiology of having a longer urethra might reduce its prevalence among elderly men [27]. Furthermore, significant gender differences were observed for osteoporosis (27.6% vs. 3.3%) and arthritis (64.7% vs. 29.7%). One theory proposed that a biological mechanism, related to menopause, can partially explain elderly women's greater risk for chronic diseases, such as osteoporosis, coronary heart disease, and cancer [28]. In addition, an excessive reporting bias and making frequent visits to a physician could have influenced elderly women's higher prevalence for chronic diseases. The gender differences in chronic diseases, nonetheless, have yet to be fully explained.

The Association Between Chronic Diseases and ADL Disability

This study observed gender-differential patterns associating specific chronic diseases with ADL disability. In agreement with previous research [9,29], a significant association between stroke, diabetes, and incontinence and ADL disability was observed in both genders. In contrast to previous findings from Western countries [12], stroke was associated with a greater risk of ADL disability among South Korean elderly men than women. By stratifying elderly women and men into three age groups (65 - 69, 70 - 79, and 80 - 89), how gender and age affected stroke's relation to ADL disability became more evident. When compared with elderly women, men who suffered a stroke experienced a greater risk of developing ADL disability in the 65 - 69 and 70 - 79 age groups (OR 15.54 vs. 7.76, $p < 0.05$; OR 23.05 vs. 5.93, $p < 0.01$), but in the 80 - 89 age group, this association seemed to be reversed (OR 12.02 vs. 21.2). Since the mean age for South Korean stroke victims was 63.4 years for men and 68.4 years for women, this confusing result could be explained by elderly men, more so than women, having suffered a severe stroke that caused mortality at an earlier age. Elderly men, additionally, had a greater risk of a 6-year stroke mortality than elderly women [30]. Furthermore, previous findings suggested a longevity advantage for female stroke victims, especially those over the age of 80 [31].

With substantial gender differences, this study also revealed that, for elderly men, cancer and diabetes were significantly associated with ADL disability in the 70-79 age group, and pulmonary diseases' risk for developing ADL disability appeared in the 80-89 age group ($p<0.05$, respectively). The severity of the impact of stroke, cancer, and pulmonary disease on elderly men could be connected to the much larger consumption of alcohol and tobacco by men than women [3,19]. Although this is an historical phenomenon worldwide, it is most especially prevalent in South Korea. Heavy, lifelong alcohol and tobacco consumption was recognized as being a socially acceptable practice for Korean men but not women (smoking: 70.2% vs. 3.4%; drinking: 83% vs. 44.6% in 1995) [19]. Severe cancer-related disability among elderly South Korean men (more so than among women) may also fall in line with their greater number of cancer-related deaths (age-standardization rates: 166.6 vs. 68.8 per 100 000 in 2005) [32]. Some empirical studies have argued that men experience life-threatening coronary heart disease or cancer whereas women are more likely to endure nonfatal chronic diseases with relatively mild symptoms such as arthritis, osteoporoses, anemia, or non-life threatening coronary heart disease [33,34].

For the elderly women in this study, however, specific chronic diseases were associated with ADL disability-such as incontinence in all three age groups and diabetes and pulmonary diseases in the 70 - 79 age group-yet this study failed to confirm significant gender differences. This result was relatively consistent with previous research that found that more women than men suffered from a disability caused by nonfatal chronic conditions [3,35]. In comparison to several previous studies [3,36,37], this study failed to prove that hypertension, musculoskeletal disorders, and elderly women's cancer were important determinants for developing ADL disability. Possibly, the severity of chronic diseases has

become less debilitating because of early detection and appropriate treatment and/or better risk management [2,38]. However, the small numerical size of the study's elderly female cancer patients could hamper our understanding of this association.

This study has several limitations. First, by using a cross-sectional design, it was unable to consider how the natural history of chronic diseases relates to ADL disability's development. Second, self-reported chronic diseases could underestimate the real prevalence of objective morbidities among the elderly. Although elderly on lower rungs of the socioeconomic ladder were more likely to develop chronic diseases and ADL disability, they apparently underreported or were unaware of their diseases, especially when their symptoms were mild. In addition, reporting-bias differences between men and women for disability or chronic diseases could influence this study results. Women might report more symptoms of disability or chronic diseases than men, due to higher somatic sensitivity whereas men might underreport these symptoms because of social and cultural norms of stoic masculinity. However, a significant amount of research found that both elderly men and women tended to report accurately their disability and serious chronic diseases-diseases such as cancer, stroke, diabetes, musculoskeletal disorders, and lung disease. Third, by using self-reported disease conditions, a recall and misclassification bias could be present. Chronic diseases for this study, nonetheless, were defined as diseases which have lasted at least three months during the past year and were diagnosed by a physician. Furthermore, this sample was collected by well-trained interviewers using a predetermined questionnaire. Thus, severe misclassification or recall bias was unlikely to influence its results. Forth, this study could not include several important chronic diseases which influence ADL disability, such as depression, Alzheimer's, and dementia. Understanding the relations between depression or dementia and ADL disability should reveal the mechanisms by which specific chronic diseases affect disability's development, but the current absence of such information prevents us from performing this analysis. Finally, this survey's sample contained all household members; thus, we could not eliminate the possibility that the members of a household share the same lifestyle, economic resources, and/or home environments. In spite of several limitations, this study used a representative sample of a random, South Korean nationwide survey and considered a relatively broad spectrum of chronic diseases (diagnosed by physicians). Therefore, this study's findings could be representative of the South-Korean elderly population.

This study showed that the prevalence of chronic diseases was much higher among elderly women than men. However, stroke in the 65-79 age group, cancer in 70-79 age group, and pulmonary diseases in the 80-89 age group created a greater risk of ADL disability among elderly men than women. This finding calls for future longitudinal research to develop an understanding of the gender differential effect of chronic diseases on ADL disability.

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