

건강위험행태인자와 일상생활 의존성과의 관련성에 대한 추적자료 분석

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A Longitudinal Study of the Relationship Between Health Behavior Risk Factors and Dependence in Activities of Daily Living

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Objectives : The purpose of this study was to shed further light on the effect of modifiable health behavior risk factors on dependence in activities of daily living, defined in a multidimensional fashion.

Methods : The study participants were 10,278 middle aged Americans in a longitudinal health study, the Health and Retirement Survey (HRS). A multi-stage probability sampling design incorporating the effect of population sizes (Metropolitan and non-metropolitan), ethnicity (the non-Hispanic White, the Hispanic, and the Black), and age (age 51-61) was utilized. Basic Activities of Daily Living (ADL) were measured using five activities necessary for survival (impairment in dressing, eating, bathing, sleeping, and moving across indoor spaces). Explanatory variables were four health behavior risk factors included smoking, exercise, Body Mass Index (BMI), and alcohol consumption.

Results : Most participants at baseline were ADL independent (1992). 97.8% of participants were independent in all ADL's at baseline and 78.2% were married. Approximately 27.5% were current smokers at baseline, and the subjects reported moderate or heavy exercise were 74.8%. All demographic characteristics and behavioral risk factors were significantly associated with the ADL status at Wave 4 except alcohol consumption. Risk

behaviors such as current smoking, sedentary life style and high BMI at Wave 1 were associated with ADL status deterioration; however, moderate alcohol consumption tended to be more related to better ADL status than abstaining at Wave 4. ADL status at Wave 1 was the strongest factor and the next was exercise and smoking affecting ADL status at Wave 4. People who were in ADL dependent at Wave 1 were 15.17 times more likely to be ADL dependent at Wave 4 than people who were in ADL independent at Wave 1. Concerning smoking cigarettes, people who kept only light exercise or sedentary life style at Wave 1 were 1.70 times more likely to be died at Wave 4 than the people who did not smoke at Wave 1.

Conclusions : All demographics and health behaviors at wave 1 had consistently similar OR trends for ADL status to each other except alcohol consumption. Smoking and exercise in health behaviors, and age and gender in demographics at Wave 1 were significant factors associated with ADL group separation at Wave 4.

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Key words : Health behavior, Activities of daily living, Middle aged, Aging, Longitudinal studies

INTRODUCTION

Physical functioning strongly affects quality of daily life. The magnitude of physical functioning problem becomes substantially greater with continuing increase in longevity and the size of the elderly population groups in Korea as well as other developed countries [1].

The average longevity of Korean population is about 77.5 years [2]. Community-based studies have investigated cross-sectional analysis of physical function as well as longitudinal analyses on the related factors of physical functioning changes among the elderly [3-5].

Health behavior risk factors have been diversely discussed in terms of physical

dysfunctioning in the elderly group. Among various health behavior risk factors, the strong effects of tobacco smoking on longevity are well known [6-8]. The financial costs of smoking have also been thoroughly studied [9,10]. In terms of morbidity, a large number of studies have documented the specific relationships between tobacco smoking and development of individual diseases. Most notable from a public health perspective are

cancer, cardiovascular disease, and respiratory disease [11-13] and relatively less is known about the relationship between smoking and disability impaired mobility, health care utilization, and self-reported health [4,14-20]. Lacroix and the colleagues found mobility loss (ability to climb stairs and walk 1/2 miles) after four years of follow-up to be more likely among those who were smokers at baseline [16]. They live longer overall and live shorter time with disability than do smokers. Never smoking was to be a consistent predictor of "healthy aging" (surviving and remaining free of major chronic illnesses and physical and cognitive impairments) in a elderly health study. The Alameda county study has provided some of the best longitudinal information regarding predictors of ill health and disability among persons age 65 and older, but current (relative to former or never) smoking was only marginally associated with a decline in physical functioning. After controlling for incident health conditions, the effect of smoking was even smaller [20].

Lack of exercise has also been shown to be related to dependence inactivities [21-25]. In the longitudinal study by Simonsick and the colleagues [24], who controlled for physical activity at baseline, increased activity not only had a positive effect on survival, but also over three years, moderate to high levels of activity reduced the risk impairment. In other studies, similar relationships have been shown for selected samples of active individuals; the effects remain after adjustment for coexisting chronic conditions [16,26,27]. An analysis from the established populations for epidemiologic studies of the elderly found that never smoking and exercise were associated with longer life expectancy [28]; however, never smoking was also associated with more years of disabled life expectancy. Another Scandinavian follow-up study found that smoking and lack of exercise at baseline were both significant predictors for subsequent receipt of disability pension [29].

Similar to what has been found in number of

studies of the effect of alcohol on dependence in daily living, a U-shaped relationship between alcohol consumption and the development of disability has also been reported. Individuals who drink a moderate amount of alcohol (usually one to two glasses per day) seem to have somewhat better health than abstainers [30]. Although the composition of the study populations has varied, several studies of seniors have reported greater declines in functional status associated with both low and high body mass index (BMI) [31]. A longitudinal study of 1,741 university alumni found that individuals who had normal weight in midlife and late adulthood, did not smoke, and exercised, lived longer and that their disability was compressed into fewer years at the end of life [32].

The study of older Americans by Lacroix and the colleagues investigated the effects of all four risk factors simultaneously [16]. Older people with moderate (compared to high) BMI, who consumed moderate amounts of alcohol (compared to no use), who were involved in regular exercise, and who did not smoke had a lower risk of losing mobility or developing a disability. In an extensive systematic literature review, Stuck and the colleagues also concluded that there was evidence for a relationship between smoking, low physical activity, no alcohol consumption (relative to moderate use), and increased body mass index on one hand and "decline in functional status" on the other [33]. The studies of successful aging found in a sample of high-functioning elderly ages 70-79 that lower education, relatively overweight, and lack of emotional support were related to a decline in physical function, while smoking or alcohol intake were not [34].

A limitation of earlier studies about these modifiable risk factors frequently lies in the sample selection (e.g., members of a runners' club). With the subjects not being very representative of the general population, this may explain why the reported effects of smoking, exercise, BMI, and alcohol

consumption on the hand various indicators of activity dependence on the others were quite variable. Small study samples and different ways of reporting smoking, alcohol consumption, and especially exercise also explain some of this variation. The measures used to operationalize morbidity, functional decline, and disability have also been quite varied [33]. Most earlier studies of disability have focused on older rather than middle-aged individuals. The purpose of this study was to shed further light on the effect of modifiable health behavior risk factors on dependence in daily living defined in a broad and multidimensional fashion. A better understanding of the role of modifiable risk factors in the development of activity dependence in middle and old age from the research findings will help to develop health promotion and maintenance programs for the elderly population.

METHODS

Samples and Survey Process

The samples of this study were 10,278 elderly people in the Health and Retirement Study (HRS). The Health and Retirement Study was a national representative longitudinal follow-up study to identify health behaviors, disability status, and medical care usage among the U.S. elderly people conducted for seven years with two year-survey intervals. The HRS samples were selected under a multi-stage probability sampling design based on two population modules (Metropolitan statistical and non-metropolitan statistical areas), 84 strata of the national physical sample frames, ethnicity (the non-Hispanic White, the Hispanic, and the Black), and age (age 51-61). The HRS conducted four wave surveys and the baseline survey was an in-home and face-to-face interview conducted in 1992 for the 1931-1941 birth cohort (and if married their spouses, regardless of age) followed by three more surveys (Wave 2, 1994; Wave 3, 1996; Wave 4,

1998) to monitor the baseline interview participants' disability and mortality status. The Wave 1 participants' disability status and health behaviors and their disability and mortality results at Wave 4 were included in the multivariate models in this study. The eligible numbers were 15,497 in Wave 1 and 12,654 of them finished the first interview survey. The response rate of Wave 1 was 81.7%. The final participant numbers were 10,278 fully monitored for their disability and mortality status through Wave 1 to Wave 4. The response rate of Wave 4 from Wave 1 was 81.2%.

Variables

Dependent Variables

Disability and mortality status: Basic Activities of Daily Living (ADL) were measured with five activities necessary for survival (included in these analyses: impairment in dressing, eating, bathing, sleeping, and moving across room or around indoors) (e.g., "Does anyone ever help you bathe or shower?"; yes/no). We divided the samples by their ADL and mortality status at Wave 4 to three groups. The independent group was alive and had no or just one difficulty among the five ADL items at Wave 4. The dependent group was alive and had two to five difficulties of the ADL items, and the death group died between Wave 1 and Wave 4 matching the HRS data set, using Social Security numbers, to the National Death Index, to confirm date of death.

Explanatory Variables

Explanatory variables of this study were demographic variables, ADL status at Wave 1, and four behavioral risk factors: smoking, exercise, BMI, and alcohol consumption registered in HRS. The demographic variables were age, race, gender, marital status, and educational years. ADL status at Wave 1 was classified to two groups (independent and dependent). Independent group had no or one

difficulty and dependent group had two to five difficulties of the ADL items at Wave 1 consistent to the ADL classification of Wave 4. Health behavior risk factors were estimated with smoking, exercise, BMI, and alcohol consumption.

Current smokers were divided into current smokers group and never or ex-smoker group. Two questions relating to exercise were used ("How often do you participate in light physical activity—such as walking, dancing, gardening, golfing, bowling, etc.? Would you say 3 or more times a week, 1 or 2 times a week, 1 to 3 times a month, less than once a month, or never?"). To create the exercise variable used in our analyses, a person who reported no exercise on either question was considered sedentary. At the other end of the spectrum, all persons who reported heavy physical activity three or more times per week were classified as doing heavy exercise. All persons who reported heavy physical activity one to two times per week, as well as those who reported light physical activity three or more times per week, were classified as doing moderate exercise. The remaining persons were classified as doing light exercise. Alcohol consumption was divided into light to moderate drinking (up to two drinks/day) and heavy drinking (more than two drinks/day) in a question ("In general do you have less than one drink a day, one to two drinks a day, three or four drinks a day, or five or more drinks a day?"). BMI is defined as weight (in kilograms) divided by height (in meters). Very low BMI ($<18.5 \text{ kg/m}^2$) and obesity (BMI $>30.0 \text{ kg/m}^2$) were contrasted with the ideal and slightly overweight category according to recent guidelines [35].

Statistical Methods

The unadjusted mortality rate (from Wave 1 to Wave 4) per 1,000 persons per year for all levels of the explanatory variables used was calculated. For those respondents who completed four waves of HRS, the unadjusted

relationship between health behavior status at baseline and the (unadjusted) proportion of the sample who reported inactivities of living using the outcome measures described above was identified.

The respondents who completed Wave 1 and Wave 4 surveys constituted the sample were used for multivariate modeling. Separate models were estimated for each of the measure of dependence activities of daily living. Using multivariate logistic regression, the observations for each respondent were classified (each HRS respondent provided three values). The explanatory variables, measured at Wave 1, were treated as time-invariant. Because observations in such a design are not independent of one another, clustering of observations at the individual level was adjusted for by obtaining Huber-White corrected standard errors. Odds ratios and 95% confidence intervals (0.05 p-value) were reported.

Multivariate logistic regression was used to analyze a 2-category nominal response (yes versus no) of the explanatory variables on three levels of dependence status at Wave 4 (independent, ADL dependent, and dead). Each model adjusts the probability of functional status transitions for competing risks from institutionalization, death, and having missing information on status. Explanatory variables considered in the models include variables representing previous functional status, age, gender, race, educational level, marital status, and living arrangements (i.e., lives with other versus lives alone). By including previous functional status models, we were able to predict the probability of transitions from precedent to antecedent functional status states.

All of the results presented were calculated with weights that account for the unequal probabilities of selection and non-response adjustments. Potential instability of the estimation process resulting from multicollinearity of predictor variables was investigated by

inspecting the bivariate correlations between pairs of predictors and regressing each predictor variable on all other predictor variables, thus determining how any single variable behaved in the presence of other variables in the model. This latter analysis provided us an indication of percentage of variation of each predictor that could be explained by all other predictors. All variables chosen a priori for investigation were included in the model except those which displayed multicollinearity with other covariates. Because marital status was so closely related to living arrangements (alone versus with others), we chose to retain marital status variable because of its clear and stable more than the latter variable. All multivariate logistic regression models were fit using the MULTILOG procedure of SUDAAN [36]. Results from these models were presented in terms of the odd ratios for being in each of the four and-of-period outcome states relative to having no disability along with their 95% confidence intervals.

As an illustration of odds ratios is obtained from the multivariate logistic regression analysis, explanatory variables were used as predictors of three dependent ADL at Wave 4 categories (independent, dependent, dead). The models that we fit use “independent” as the reference category for each of the logistic models that can be obtained from the other response categories. For example, the logistic model for white women relating the probability of being “dependent” to the probability of being “independent” would be specified as:

$$\text{Log} (\text{Prob dependent} / \text{Prob Independent}) = \mu_i + \tau_{Gi} + \tau_{Ki}$$

Where μ_i , τ_{Gi} , and τ_{Ki} represent the intercept, gender effect, and race effect, respectively, were clues for this logistic model. The ratio of the odds of being “dependent” relative to “independent” for men versus women, controlling for White race, is determined as follows. Specific illnesses were considered confounding variables between the risk factors and the chosen disability outcomes; however

were therefore not included in the models.

$$\begin{aligned} \text{OR}_{\text{gender}} &= \exp \\ & [\log (\text{Prob dependent} / \text{Prob Independent})]_{\text{men}} \\ & - \log (\text{Prob dependent} / \text{Prob Independent})_{\text{women}}] \\ & = \exp [(\mu_i + \tau_{Gi} + \tau_{Ki}) - (\mu_i + \tau_{Ki})] \\ & = \exp (\tau_{Gi}) \end{aligned}$$

RESULTS

Participants’ characteristics at baseline (Wave 1) were identified in terms of their general characteristics (age, race, gender, marital status, and educational status), health behavior risk factors (smoking, exercise, BMI, and drinking), and ADL status at Wave 1 cross tabling with the ADL status at Wave 4 (Table 1). A total of 88.1% Wave 1 ADL independent people stayed in the same ADL status, 7.1% moved to the dependent status, and 4.7% were died at Wave 4. Some Wave 1 ADL dependent people made a reverse change of their ADL status from the dependent to the independent group by 28.8%. 97.8% of participants were

independent in all ADL’s at baseline and 78.2% were married. Approximately 27.5% were current smokers at baseline, and the subjects who took moderate or heavy exercise were 74.8%.

ADL status at Wave 4 were significantly different by the ADL status at Wave 1, demographic variables (age, race, gender, marital status, and educational years), and the four behavioral risk factors. Most participants at baseline were ADL independent (Table 1). ADL dependent people at Wave 1 were more likely to be the ADL dependent or dead than the ADL independent group at Wave 1. Concerning demographic characteristics, the participants who were between 51-54 years old, the White, women, married, and with at least high school graduation had better ADL status at Wave 4 than the participants who were older than 55, had other racial background, were men, were not married, and had lower educational status. Health behavior risk factors showed similar pattern of relationship with

Table 1. ADL status at Wave 4 compared by participants’ characteristics at Wave 1 Unit: person (%)

Variables at Wave 1	ADL status at Wave 4			Total	χ^2
	Independent	Dependent	Dead		
ADL status at Wave 1					
Independent	8,859 (88.1)	471 (7.3)	729 (4.7)	10,059 (100.0)	749.3*
Dependent	63 (28.8)	89 (40.6)	67 (30.6)	219 (100.0)	
Age (year)					
51 - 54	3,865 (90.0)	213 (5.0)	217 (5.1)	4,295 (100.0)	80.9*
55 or older	5,057 (84.5)	37 (5.8)	579 (9.7)	5,983 (100.0)	
Race					
White	6,807 (89.2)	314 (4.1)	513 (6.7)	7,634 (100.0)	156.4*
Others	2,115 (80.0)	246 (9.3)	283 (10.7)	2,644 (100.0)	
Gender					
Women	4,952 (88.8)	328 (5.9)	298 (5.3)	5,578 (100.0)	92.0*
Men	3,970 (84.7)	232 (5.0)	484 (10.3)	4,686 (100.0)	
Marital status					
Married	7,109 (88.6)	359 (4.5)	554 (6.9)	8,022 (100.0)	101.4*
Others	1,813 (80.9)	201 (9.0)	228 (10.1)	2,242 (100.0)	
Educational years					
Years greater than 12	3,451 (91.5)	108 (2.9)	211 (5.6)	3,770 (100.0)	123.8*
Years 12 or less	5,471 (84.1)	452 (7.0)	585 (9.0)	6,508 (100.0)	
Current smoking					
Never or ex-smoker	6,648 (89.3)	370 (5.0)	426 (5.7)	7,444 (100.0)	157.2*
Current smoker	2,274 (80.6)	190 (6.7)	356 (12.6)	2,820 (100.0)	
Exercise					
Moderate or heavy	6,884 (89.6)	320 (4.2)	482 (6.3)	7,686 (100.0)	204.5*
Light or sedentary	2,038 (78.6)	240 (9.3)	314 (12.1)	2,592 (100.0)	
Body Mass Index (BMI)					
BMI 30 or less	6,924 (87.6)	360 (4.6)	620 (7.8)	7,904 (100.0)	53.1*
BMI greater than 30	1,998 (84.2)	200 (8.4)	176 (7.4)	2,374 (100.0)	
Alcohol consumption					
Abstainer	3,325 (83.1)	322 (8.1)	355 (8.9)	4,002 (100.0)	102.3*
Drinker	5,597 (89.1)	238 (3.8)	441 (7.1)	6,276 (100.0)	

* p < .001

ADL status to those at Wave 4 except alcohol consumption. Never or ex-smokers at Wave 1 had greater ADL independent percent at Wave 4 than the smokers at Wave 4. Moderate or heavy exercising people kept more ADL independent status at Wave 4 than the people who had sedentary health behavior. The people whose Body Mass Index (BMI) were equal or less than 30 had better ADL independent status at Wave 4 than the people whose BMI were greater than 30; however, alcohol consumption had different pattern of ADL status. The drinker group at Wave 1 had greater ADL independent status at Wave 4 than the abstainer group at Wave 1.

Table 2 showed Odds ratios (OR) of the Wave 1 risk factors to be exposed to ADL dependent or dead at Wave 4. All independent variables were organized in the dichotomous category and the dependent variable, the ADL status at Wave 4 was dichotomously compared the ADL dependent with the ADL independent, and the dead with the ADL independent at Wave 4.

In comparisons between the ADL independent and dependent at Wave 4, ADL status at Wave 1 was a significant risk factor of the ADL dependent status at Wave 4 ($p < .001$). The ADL dependent at Wave 1 were more likely to be the ADL dependent at Wave 4 than the ADL independent and the OR was 2.70. Education, marital status, and race of general characteristics were significant factors. The educational period less than 12 years (OR=1.85), the unmarried status (OR=1.58), and the other racial background except the White (OR=1.69) were significant demographic risk factors more likely to be ADL dependent at Wave 4. All four health behaviors affected the ADL status at Wave 4. Current smoking (OR=1.42), few or sedentary exercising (OR=1.68), and BMI score greater than 30 (OR=1.52) at Wave 1 were significant behavioral risk factors more likely to be ADL dependent at Wave 4. However, alcohol consumption showed different risk taking

Table 2. Multivariate multinomial logistic regression: relationships between Wave 1 characteristics and Wave 4 ADL status

Variables at Wave 1	Dependent at Wave 4 [†] (n=560)		Dead at Wave 4 [†] (n=782)	
	Odds Ratio (95% CI)	Coefficient estimate	Odds Ratio (95% CI)	Coefficient estimate
Intercept		-3.87 [*]		-3.95 [*]
Current smoking				
Never or ex-smoker				
Current smoker	1.42 (1.17 - 1.73)	0.35 [*]	2.34 (1.99 - 2.74)	0.85 [*]
Exercise				
Moderate or heavy				
Light or sedentary	1.68 (1.39 - 2.03)	0.51 [*]	1.70 (1.44 - 2.00)	0.53 [*]
Body Mass Index (BMI)				
BMI 30 or less				
BMI greater than 30	1.52 (1.25 - 1.85)	0.42 [*]	1.00 (0.83 - 1.20)	0.00
Alcohol consumption				
Abstainer				
Drinker	0.58 (0.48 - 0.70)	-0.55 [*]	0.71 (0.61 - 0.84)	-0.34 [*]
Age				
51-54				
55 or older	1.13 (0.93 - 1.36)	0.12	1.94 (1.63 - 2.30)	0.66 [*]
Race				
White				
Others	1.69 (1.39 - 2.05)	0.52 [*]	1.37 (1.15 - 1.62)	0.31 [*]
Gender				
Women				
Men	1.16 (0.96 - 1.41)	0.15	2.17 (1.85 - 2.56)	0.78 [*]
Marital status				
Married				
Others	1.58 (1.29 - 1.94)	0.46 [*]	1.40 (1.17 - 1.68)	0.34 [*]
Educational years				
Years greater than 12				
Years 12 or less	1.85 (1.47 - 2.32)	0.61 [*]	1.29 (1.08 - 1.53)	0.25 [*]
ADL status at Wave 1				
Independent				
Dependent	15.17 (10.60 - 1.71)	2.70 [*]	8.54 (5.83 - 12.51)	2.14 [*]

^{*} $p < .001$

[†] Reference group: Independent group at Wave 4 (n=8922)

pattern that the alcohol abstainers had more risk to be the ADL dependent at Wave 4 than the drinkers.

The comparisons between the ADL independent and dead at Wave 4 showed similar patterns of that between ADL independent and dependent. ADL status at Wave 1 was a significant risk factor of the ADL dependent status at Wave 4, which the ADL dependent at Wave 1 were more likely to be the dead at Wave 4 than the ADL independent (OR=2.14). The risk of demographic variables at Wave 1 on the dead at Wave 4 seemed greater between the ADL independent and the dead at Wave 4. Men (OR=2.17), the older than 55 (OR=1.94), unmarried (OR=1.40), other than the White (OR=1.37), and less than 12 educational years (OR=1.29) were significant risk taking characteristics of the dead at Wave 4. The risk behaviors were significant factors of ADL deterioration from Wave 1 to Wave 4. Current smoking

(OR=2.34) and light or sedentary exercise (OR=1.70) at Wave 1 were significant behavioral risk characteristics more likely to become the dead at Wave 4. The OR of BMI risk was 1.0 and the alcohol abstainers were slightly more likely to be the dead at wave 4 (OR= 0.71).

DISCUSSION

The differences of dependence activities by the independent variables between Wave 1 and Wave 4 were consistent both in direction and seriousness. About 28.8% of the dependent ADL participants at Wave 1 improved their daily living activity status to independent at Wave 4 and the other 71.2% participants kept or decreased their ADL status. The 28.8% participants who improved their ADL status from Wave 1 to Wave 4 could be explained in terms of temporary illness and treatment. People frequently get diverse light temporary

diseases such as cold or mild gastroenteric disorder and most their diseases are treated or at least get better although their diseases are serious. Thus, approximately one fourth of the population might be under some temporary illness status and treated that or changed their health behaviors and improved their health status through the follow-up period. The independent status of daily living and health behavior patterns at baseline should be a primary strategy for well-being among the middle-aged to elderly population. Anderson and the colleagues suggested that the initial disability level was a strong predictor of disability status and the other significant predictor was health habit in their longitudinal elderly function research [3].

ADL dependence at Wave 1 was the most significant indicator of ADL dependence or dead at Wave 4. ADL dependence had 2.7 OR on the ADL dependent status and 2.14 OR on the dead status compared with the ADL independence at Wave 4, which means the baseline ADL dependent people, compared with the baseline ADL independent people, 2.14 times more likely to die at Wave 4. Among health behavioral risk factors, smoking and little exercise had clear associations with the ADL dependence or the dead at Wave 4 as expected, in particular, smoking had greater OR to the dead status (OR=2.34) than to the dependent status (OR=1.42) at Wave 4, which means that smoking had consistent negative effects on health status and daily living dependence. This study classified smoking status into two: never or ex-smoker and current smoker. The association between cigarette smoking and dependence activity is in agreement with recent studies showing that mortality associated with smoking can be decreased if they stopped smoking before their middle age because continuous smoking history was a primary factor predicting dependence activity of daily living in elderly population [16-38]. Thus, the benefit of quitting cigarette in this study can be also used

to emphasize the health benefits of smoking cessation that are utilized as part of public health information efforts aiming cessation.

The same tendency was detected in the little exercise or sedentary behavior characteristic as the smoking behavior. Clark found that increased walking frequency significantly predicted the better life functional outcomes in a large cohort project, NHANES I [39], and also reported a significant relationship between daily disability and less or no recreational activities [40]. Fries and the colleagues also reported that reduced disability with age was related to increased aerobic activity, strength, fitness, and increased organ reserve as well as postponed development of osteoarthritis [22]. However, the BMI greater than 30 had greater OR to the ADL dependence (1.52) than to the dead (1.00) at Wave 4, which implied that BMI had limited contribution on the ADL deterioration.

Alcohol consumption had opposite contributions on the ADL change. Drinkers showed better ADL status than the alcohol abstainers at Wave 1 and that result was consistent to the ADL dependence and the dead at Wave 4. Alcohol consumption different from the other health behaviors had been reported its positive association with better health [20,30]. The Alameda County study found that the mild to moderate drinkers were healthy more than the alcohol abstainers; however, binge or heavy drinkers had significantly more disease or accident records with worse health status [30]. That is, moderate drinking had some positive effect to keep the ADL independence and healthy life.

Regarding demographic characteristics, age and gender patterns naturally made sense because woman, generally, lives longer than man and aging is comprehensively related with health deterioration and illness status. Race and marital status indicated that ADL dependence more likely happen to the other racial groups except the White and the unmarried people. Racial background in the United States was

associated with socioeconomic status, which means that the non-Hispanic White was more likely to have better economic and social status than the other racial groups such as the Hispanic, the Black, or the Asian. The better socioeconomic status they have the better health status they keep. The association between ADL dependent status and the unmarried condition could be explained in terms of mental health, in particular, social and emotional support from the intimate caregivers. Regardless of age group, relational intimacy and social support well predicted people's general health status in Biering-Sorensen and Berkman's studies [29,30].

Although this study demonstrated strong and consistent associations among smoking, exercise, BMI, and alcohol, and three classifications of daily living dependence inactivities, it is possible that other, unmeasured, confounding variables intercepted between the risk factors and the subsequent outcomes. A primary confounding factors might be chronic disease and health status at Wave 1. Health behavior changes due to illness might disturb clear understanding about the cause and effect relationship between risk behavior and dependence inactivities in this study. We employed multivariate analytic methods (Logistic regression analysis) to control possible confounding effects between independent variables. Another limitation of this study lies on classification of the ADL status. We classified the participants' activity dependence with only five living disability questions to three groups: independent, dependent, and dead. The five ADL questions might be not large enough to justify that the behavioral risk classification was valid; furthermore, the classification rule of ADL which we used had little evidence from the related previous research because there is no prevalently used classification of ADL. It means that our classification might have classification error or deviation from other ADL studies; although this study had

representative samples minimizing estimation or classification errors.

This study has three major strengths relative to past research on this topic. First, the inclusion of middle-aged as well as elderly persons allows identification of the impact of modifiable risk factors on dependence inactivities prior to the retirement years. Second, the large sample sizes and longitudinal nature of the survey also provide strong research design benefits. The results are generalizable to the noninstitutionalized population of Americans age 50 and older. That is, the national scope of the HRS study strengthened the generalizability of the ADL status and risk behavior findings. The sample was large and representative of the U.S. population in terms of sociodemographic factors. The longitudinal design, particularly the ability to relate the effect of time with risk behavior changes, makes it possible to estimate the positive effects of risk behavior changes on declining rates of dependence inactivities with confidence. Third, all independent (explanatory) variables were considered confounding factors between the behavioral risk factors and dependence inabilities in daily living through multivariate (logistic regression analysis) controlling covariate effects on each other; making interpretation of the public health significance of confounding factors on dependence inabilities in daily living.

SUMMARY AND CONCLUSIONS

Physical functioning strongly affects quality of daily life, especially in the modern well-being focused society. The magnitude of physical functioning problem becomes substantially greater with continuing increase in longevity and the size of the elderly population in Korea than any other developed countries. Thus, maintaining moderate physical functioning of middle-aged or elderly population is the prioritized topic for national health promotion as well as economic

development. The purpose of this study was to shed further light on the effect of modifiable health behavior risk factors on dependence in daily living defined in a broad and multidimensional strategy. A better understanding of the modifiable risk factor associated with the activity dependence in the middle and old age from this research will help to develop health promotion and maintenance programs for the elderly population.

The study participants were 10,278 middle aged Americans who participated in the Wave 1 and the Wave 4 of the Health and Retirement Survey (HRS) which were conducted in 1992 for the 1931-1941 birth cohort followed by three more surveys (Wave 2, 1994; Wave 3, 1996; Wave 4, 1998) in the form of an in-home and face-to-face interview to monitor the baseline interview participants' disability and mortality status. A multi-stage probability sampling was employed to control the effects of population sizes, ethnicity, and age. Basic Activities of Daily Living (ADL) were measured using five activities necessary for survival (impairment in dressing, eating, bathing, sleeping, and moving across indoor spaces). Explanatory variables were four health behavior risk factors included smoking, exercise, Body Mass Index (BMI), and alcohol consumption.

Most participants at baseline were ADL independent (1992). 97.8% of participants were independent in all ADL's at baseline and 78.2% were married. Approximately 27.5% were current smokers at baseline, and the subjects reported moderate or heavy exercise were 74.8%. All demographic characteristics and behavioral risk factors at Wave 1 were significantly associated with the ADL status at wave 4 except alcohol consumption. Risk behaviors such as current smoking, sedentary life style and high BMI at Wave 1 were significantly associated with ADL status deterioration at Wave 4; however, moderate alcohol consumption tended to be more related to better ADL status than abstaining at Wave 4.

ADL status at Wave 1 was the strongest factor and the next was exercise and smoking affecting ADL status at Wave 4. People who were in ADL dependent at Wave 1 were 15.17 times more likely to be ADL dependent at Wave 4 than people who were in ADL independent at Wave 1. Concerning smoking cigarettes, people who kept only light exercise or sedentary life style at Wave 1 were 1.70 times more likely to be died at Wave 4 than the people who did not smoke at Wave 1.

In summary, all demographics and health behaviors at Wave 1 had consistently similar OR values for ADL status to each other except alcohol consumption. Smoking and exercise in health behaviors, and age and gender in demographics at Wave 1 were significant factors associated with ADL group separation at Wave 4. The major findings about risk factors of ADL status in this study suggested two major recommendations for future research. The first is that more community-based exercise and smoking cessation programs should be developed and implemented for the middle to elderly population because exercise and non-smoking status were beneficial to better ADL status. The other recommendation is that those ADL promoting programs need to be diversely developed and implemented by age and gender characteristics.

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