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Socio-economic and health determinants of transitions to adult dependency in South Korea, 2008–2014

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ABSTRACT

Objectives: The aim of this study is to identify the determinants of transitions to and possibly back from dependence.
Study design: The Korean Longitudinal Study of Aging, 2006–2014.
Methods: The transitions between non-dependence and difficulties in activities of daily living —instrumental (IADL) or not (ADL)—are distinguished between stability, deterioration, death, or recovery in multilevel logistic regressions.
Results: Controlling for other covariates, women are more likely to remain without difficulty than men, dependants are more likely out of the labor force or unemployed, city dwellers are more likely dependent. Subjective health helps predict health two years later, as grip power, score of cognition, depression, cardiac and cerebrovascular diseases, and the number of difficulties in IADL (but not in ADL). Dependants with difficulties in IADL reporting no caregiver survive longer but are less likely to recover. Difficulties in ADL overwhelm any other available determinant. The Gompertz-like increase in the death rate with age no longer holds true for ADL dependants. Cardiac and cerebrovascular pathologies and smoking and drinking favor the transition to disability.
Conclusions: Socio-economic and medical factors identify a multifactorial determination of the risk to dependence and changes in dependence status, controlling for each effect and selection bias.

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Introduction

Transition to dependence among adults has been studied in wealthy countries[1–4] but not yet in South Korea, where research has focused on care insurance.[5,6] Functional dependence[1,7] is measured by difficulties in activities of daily living (ADL), which comprise dressing, face washing, showering, eating, getting up, using the toilet, and bladder control, or in instrumental activities of daily living (IADL), which correspond to lower levels of disability, including assistance needed for personal grooming, housework, preparation of meals, doing laundry, going out for a short distance, going out using transportation, shopping, managing money, making phone calls, taking medication on time.

Previous studies in the US, Europe, or Japan have shown that functional dependence deteriorates with age,[8] but some dependants recover,[9,10] that dependent women were less likely[2] or more likely[8] to recover than men. Income and education would have no effect.[8,9] Smoking or drinking would have no effect[9] or significant effects.[11] Functional difficulties would be associated with unemployment[12] and lack of social life.[13] Body mass and retiree status,[11] depression, chronic disease, and cognitive impairment[8] would favor transition to dependence; IADL dependants would likely recover;[9] decedents would often become disabled before death,[14] and recovery could be more frequent than deterioration to dependence, but there is a bias of ignoring dead people.[6,15]

The purpose of this study is to identify the role of pathologies and socio-economic determinants in the transitions between no-dependence, IADL dependence, ADL dependence, and death among a representative longitudinal five-wave study of adults between 2006 and 2014.

Methods

The Korean Longitudinal Study of Aging (KLoSA) was designed to 'improve understanding of Korea's population aging and to offer insights for policy-making and academic studies' (Supplementary material).[16] KLoSA is a nationally representative panel survey conducted every second year. At baseline, KLoSA respondents completed a detailed interviewer-administered questionnaire, eliciting information pertaining to their health, employment, household income after tax, education, and social welfare benefit.[19] Most of the missing values concern variables of income and asset, ranging from 10 to 20%. The imputed values we use are those supplied by Korea Employment Information Service,[16] based on a hot-deck method with modified predictive mean matching.[17]

The variable of interest is the status of dependence, which is defined as 'experiencing difficulties in one or several activities of daily living and instrumental activities of daily living'.[16] The questions asked by the interviewer to each adult member older than 45 years of the household are as follows: 'Do you have difficulties with dressing, including taking clothes out of a closet and buttoning or zipping up? Do you need someone to help you with that?' Answers are either 'No, I don't need any help'; 'Yes, I need help to some extent'; 'Yes, I need help in every respect'. The transitions to be measured between dependence statuses occur during two-year inter-wave intervals; the initial respondent's status for each transition is the status he or she has at the wave beginning the two-year interval.

Table 1 presents potential explanatory variables of the transitions between dependence statuses: sex; age (for those older than 45 years); lives in a house or a flat; subjective health; number of children in the household; education level; place of residence (metropolis, city, town, or rural area); income; activity; and health considerations such as body mass index (questions 'How much do you weigh?' and 'How tall are you?'), smoking, alcohol consumption ('How often did you drink [alcohol] in a month?'), depression, points of cognition, grip power ('I will ask you to squeeze this handle as hard as you can, just for a couple of seconds and then let go. I will take alternately two measurements from your right and left hands'), arthritis, cancer, cardiac disease, cerebrovascular disease, diabetes, hypertension, liver disease, lung disease, prostatic disease, psychiatric disease, and traffic accident ('Are you currently taking any medication or receiving treatment for [disease]').

We use the number of difficulties which we group into 'fewer or the same number' and 'more', to have enough data in the estimations. This grouping makes this the most detailed study ever carried out on transitions to dependence. The 7-item ADL and 10-item IADL scores to measure dependence were validated on the KLoSA.[18] The covariates include the number of difficulties at the previous wave, so the wave 2006 is used only through lagged values in 2008. Multilevel (because the same individual may experience several transitions) logistic regressions are used to estimate the associations between each variable and the probabilities for an individual of being in a given state at wave $t+2$ years, knowing the state where this individual was at wave t. The states shown on Fig. 1 imply three regressions from 'no dependence' (to death, IADL, or IADL), four from 'IADL dependence' (to death, recovery, increase of the number of IADL difficulties, or ADL), and three from 'ADL dependence' (to death, IADL, or recovery). All regressions were conducted using amL, version 2.09, and all P-values are two sided. Standard deviations of the coefficients mentioned in the following section are in the corresponding tables.

Results

The KLoSA comprises data on 10,254 persons aged 45–107 years followed up from 2006 to 2014. It was augmented with 920 new randomly sampled adults in 2014. The KloSA sample totals 10,254 respondents older than 45 years in 2006, 8875 in 2008, 8229 in 2010, 7813 in 2012, and 8387 in 2014.[19] After excluding those having missing values for the variables used in the regressions below, 10,230 individuals aged 45 years and older in 2006 were retained and followed up until 2014. For the year 2012, the unweighted N are 7109 for the state 'no difficulty,' 334 for 'difficulties in IADL, and 167 for 'difficulties in ADL.' Men are overrepresented in difficulties in IADL, and women in difficulties in ADL, but women also live longer and

Table 1 – Weighted means for continuous variables and percent answering 'entirely needing help' to the mentioned item, for the year 2012.

Variable	No serious difficulty	Difficulties in IADL	Difficulties in ADL	Variable	From no dependency	Difficulties in IADL	Difficulties in ADL
USD annual income, men	18,796 (SD = 16,781)	13,513 (SD = 14,141)	6126 (SD = 6299)	Points of cognition*	25.7 (SD = 5.4)	20.6 (SD = 8.1)	14.8 (SD = 9.5)
USD annual income, women	6855 (SD = 11,012)	2953 (SD = 3556)	8427 (SD = 30,598)	Grip power (kg)	24.7 (SD = 9.1)	24.2 (SD = 10.9)	14.9 (SD = 6.5)
Men	45.8	61.0	43.6	Alcohol	4.8	7.8	1.0
Wage-earner	22.2	13.2	0.0	Smoking	29.6	39.6	22.2
Self-employed	19.5	9.0	2.6	Cardiac disease	3.7	8.5	4.5
Non-paid family aid	4.2	1.1	0.0	Cerebrovascular	2.2	8.9	20.3
Unemployed	0.6	0.6	0.0	Cancer	2.5	2.9	5.0
Inactivity	53.5	75.9	97.4	Lung disease	1.3	4.3	4.7
Age 47-58 years	29.4	14.3	8.1	Liver disease	1.3	1.9	1.1
Age 59-70 years	43.3	29.9	22.8	Depression	5.1	20.3	26.5
Age 71-82 years	23.7	33.0	39.1	Arthritis	11.6	15.5	17.2
Age 83-94 years	3.6	21.1	26.9	Diabetes	8.5	9.9	20.4
95+ years	0.1	1.8	3.1	Hypertension	20.7	24.6	26.8
Retired	27.1	45.8	48.0	Prostate	3.1	6.4	7.7
Illiterate	38.5	59.6	64.6	Psychiatry	1.5	6.2	16.6
Can read, elementary	49.9	33.8	30.5	Traffic accident	0.3	0.4	0.0
Middle school +	11.7	6.6	4.9	Body mass index [kg/m^2]	23.4 (SD = 23.3)	22.5 (SD = 15.4)	21.0 (SD = 15.4)

N = 15,926,452 for 'no serious difficulty,' 657,834 for difficulties in IADL, 304,266 for difficulties in ADL.
ADL, activities of daily living; IADL, instrumental activities of daily living; SD, standard deviation.
* Points of cognition is a score between 0 and 30 calculated from a series of questions.

age is related to difficulties in ADL. Alcohol and tobacco consumption are higher and cardiac diseases are more prevalent for those in IADL, but men are also overrepresented. Other baseline sociodemographic characteristics are shown in Table 1.

In logistic regressions, the probability of dying after controlling for other covariates increases rapidly with age for non-dependants (coefficients 0.65, 1.93, 2.98 in Table 2) and for 82 to 93-year-old IADL dependants (1.28 in Table 3), but no disease and neither age, sex, nor other factors are significant for ADL dependants (Table 4), because their mortality rate is very high (70.4% on average).

The probability of onset of difficulties in IADL also increases rapidly with age (coefficients 0.75, 1.68 in Table 2), as does the probability of onset in ADL (coefficients 0.50, 1.30 in Table 2). However, age is not significant in the increase in difficulties in IADL, in the deterioration to difficulties in ADL or in recovery from them (Table 3).

Men die earlier than women and are more likely to face difficulties in IADL (coefficients 0.39 and 0.77 in Table 2).

Every additional 1000 wons decreases the risk of IADL by 3.7% (coefficient: 5.79 in Table 2); income has no effect for IADL dependants (Table 3). Retirement and education have no significant effects (Tables 2 and 3). Unemployed and out-of-the-labor-force people die sooner than others (coefficients −0.15 for 'wage-earners,' −0.30 for 'self-employed,' and −0.58 for 'non-paid family' in Table 2) and more likely become dependent (−0.29 toward IADL; −0.55, −0.54, and −1.10 toward ADL in Table 2). Respondents with no difficulties and with good self-reported health have a lower mortality (−0.20 in Table 2) and less likely experience difficulties in IADL or ADL (−0.51 and −0.55). Residence in a house provides a longevity premium (−0.15). Life expectancy improves over time (−0.50, −0.53, −0.34 [reference 0 for 2014]).

People with no dependence die later in rural areas (0.48 for metropolis, 0.50 for city in Table 2) and less likely become dependent (to IADL: 0.25 for metropolis, 0.27 for city; to ADL, 0.39 for metropolis); IADL dependants inhabiting metropolises die sooner (0.73 in Table 3), and their difficulties in IADL are more likely to increase (0.86), but they also recover more likely (0.72).

Overweight is not a direct cause of death or dependence (not significant coefficients of BMI in all tables). Smoking and drinking favor death and dependence (0.12 and 0.36 and 0.09 and 0.25, respectively, in Table 2). Depressed non-dependants die earlier (0.17).

Lower cognitive performance among non-dependants is associated with earlier death or dependence (−0.34, −0.96, and −1.13 in Table 2). Grip power and cognition score are significant for non-dependants (−1.14 and −1.73). Cardiac diseases (0.25 and 0.30) and cerebrovascular diseases (0.61 and 0.74) both accelerate death or generate IADL difficulties but not significantly ADL ones. Cancer, diabetes, and liver diseases significantly increase mortality among non-dependants (0.23, 0.21, and 0.36, respectively, in Table 2); liver diseases increase mortality among IADL dependants (0.93 in Table 3), but none of these diseases leads to ADL dependence. The fact that the coefficients of these diseases are not significant for the transition to dependency does not demonstrate that people with these diseases do not become dependent at the end of their

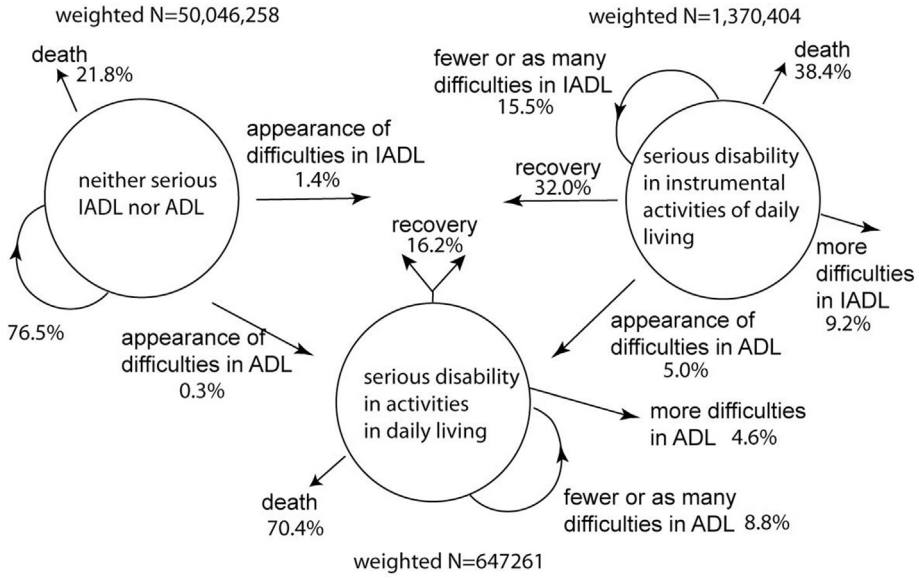

Fig. 1 – Transitions from each dependency status. The percentages are means over the 3 two-year intervals over the period 2008-2014. ADL, activities of daily living; IADL, instrumental activities of daily living.

lives but only that their time spent in dependence is often too short to be captured when two years separate successive waves of the survey. This is part of the limitations explained at the end of the article. Dependants declaring no caregiver die later (−0.67 in Table 3) but are less likely to recover (−0.56).

The significant individual-specific standard deviations (1.25 for non-dependants, 0.93 for IADL dependants, 0.97 for ADL dependants) indicate individual diversity of episodes. The non-significant correlations between the perturbations with IADL or ADL dependants indicate statistical independence of IADL and ADL risks.

Discussion

This study aims at informing public health interventions to limit the prevalence of dependence, which nowadays is a public health challenge due to South Korea's rapid aging and associated costs.

This study showed that the mortality rate is no longer Gompertz-like which corresponds to the hazard rate of mortality as an exponential of age for ADL dependants as it is for non-dependants and even for IADL dependants. This mortality rate is concealed by the dependence preceding death: difficulties in ADL are a signal of imminent death, a selection of the most disabled, so that age is no longer a salient determinant. Boaz[20] also found that ADL dependants die regardless of age, but her sample was made of institutionalized people, which involves a selection bias toward heavy dependence.[22] This study avoids this bias because dependants receive care at home.

We confirm that probabilities to become dependent, either IADL or ADL, increase with age,[8] but we find no further deterioration for people that are already dependants.[8] We confirm that IADL dependants are more likely to recover than become ADL dependants[9] and that recovery from IADL dependence is more likely than deterioration to ADL dependence. This result takes into account deceased persons, which was not the case in previous studies.[6,15] However, this situation no longer applies to ADL dependants, for whom mortality overwhelms recovery. As expected, after controlling for other variables, non-dependent men die earlier and are more likely to become dependent than non-dependent women. With regard to the contradictory results about dependent women recovering less[2] or more likely than men,[8] the study brings evidence that there is no gender difference in recovery or in mortality among dependants, at least in South Korea.

This study confirms the absence of effect of education,[8,9] but income, which was found to have no effect,[8,9] protects against lower levels of disability. While a strong debilitating effect was assigned to retirement for a US sample,[11] we find no such effect but highlight that employment versus unemployment[15] and situation of out of the labor market, which is connected with lack of social life,[13] protects from dependence. Self-employment, which requires having all one's skills, conceals a selection effect, more than wage-earning, not to mention inactivity.

Living in a house rather than a flat increases longevity. Living in rural areas is correlated with less dependence, but this comes from the fact that in South Korea, the most dependent individuals move into nursing homes and residential care facilities (not included in the KLoSA survey), which are concentrated in cities.

Doubt about the effect of smoking and alcohol consumption (none[9] or present[11,21]) is dispelled in favor of positive effects on the risks of death and of transition to ADL dependence but no significant effect on transition to IADL, recovery, or further deterioration. The latter two transitions

Table 2 – Logistic regression of the transition probabilities from 'no dependency'.

Variable	Transition to death		Transition to IADL		Transition to ADL	
	Coeff.	Std	Coeff.	Std	Coeff.	Std
Constant	−0.30**	0.11	−1.58**	0.18	−2.06**	0.34
Sex	0.39**	0.05	0.77**	0.10	0.59**	0.17
45 ≤ Age <58	Ref = 0		Ref = 0		Ref = 0	
58 ≤ Age <71	0.08	0.05	0.04	0.09	0.08	0.19
71 ≤ Age <82	0.65**	0.06	0.75**	0.10	0.50**	0.20
82 ≤ Age <93	1.93**	0.10	1.68**	0.15	1.30**	0.27
Age >93	2.98**	0.59	.		.	
Period 2008–2010	−0.50**	0.08	−0.22**	0.07	−0.16	0.15
Period 2010–2012	−0.53**	0.08	−0.13	0.10	0.13	0.19
Period 2012–2014	−0.34**	0.08	−0.11	0.09	0.10	0.14
Lives in a house	−0.15**	0.03	−0.04	0.07	−0.20	0.12
Good subjective health	−0.20**	0.05	−0.51**	0.07	−0.55**	0.14
Parity	−0.50**	0.07	−0.70**	0.13	−0.04	0.22
Can read & elementary school	Ref = 0		Ref = 0		Ref = 0	
Middle and high school	−0.01	0.04	−0.13	0.08	0.04	0.16
College and post-college	0.10	0.06	−0.19	0.12	−0.31	0.36
Metropolis	0.48**	0.05	0.25**	0.09	0.39**	0.18
City	0.50**	0.06	0.27**	0.10	0.17	0.19
Town and rural	Ref = 0		Ref = 0		Ref = 0	
Income	0.92	0.84	−5.79**	2.30	−0.16	0.15
Retired	0.02	0.06	−0.05	0.08	−6.97	7.32
Salary	−0.15**	0.06	−0.16	0.11	−0.55**	0.14
Self-employed	−0.30**	0.06	−0.29**	0.11	−0.54**	0.26
Non-paid family	−0.58**	0.11	−0.15	0.20	−1.10**	0.37
Unemployed	−0.10	0.16	−0.18	0.28	−0.22	0.49
Out of the labor market	Ref = 0		Ref = 0		Ref = 0	
Body mass index	−1.99	1.28	−0.70	2.36	−6.69	4.91
Smoking	0.12**	0.05	0.12	0.08	0.36**	0.16
Alcohol	0.09**	0.03	0.10	0.11	0.25**	0.11
Depression	0.17**	0.07	−0.06	0.10	0.22	0.17
Points of cognition	−0.34**	0.10	−0.96**	0.14	−1.13**	0.24
Grip power	−1.14**	0.25	−0.26	0.37	−1.73**	0.78
Arthritis	−0.11	0.06	0.12	0.11	0.09	0.21
Cancer	0.23**	0.11	−0.43	0.31	0.10	0.45
Cardiac disease	0.25**	0.10	0.30*	0.16	−0.03	0.41
Cerebrovascular disease	0.61**	0.14	0.74**	0.18	0.40	0.33
Diabetes	0.21**	0.07	0.10	0.12	0.05	0.22
Hypertension	−0.06	0.05	−0.09	0.09	−0.06	0.17
Liver disease	0.36*	0.19	0.44	0.30	.	
Lung disease	0.27	0.16	−0.34	0.31	0.61	0.37
Prostatic disease (regression for men)	0.25	0.21	−0.29	0.20	−0.33	0.39
Psychiatric disease	0.08	0.16	0.23	0.25	0.38	0.35
Traffic accident	−0.18	0.12	0.27	0.17	0.08	0.38

N = 25,102 spells for 10,230 individuals. **: significant at 5%. Intraindividual dispersion: SD = 1.25** (0.04); for death, SD = 0.27** (0.02); for transition to difficulties in IADL, SD = 1.15** (0.01); for transition to difficulties in ADL 1.02** (0.02). Correlations between death and difficulties in IADL 0.91** (0.02), between death and transition to difficulties in ADL 0.06 (0.04); between transition to difficulties IADL and to ADL 0.04 (0.13). ADL, activities of daily living; IADL, instrumental activities of daily living; SD, standard devaition.

concern dependent people who have a reduced consumption of alcohol and tobacco. The non-significant effect on the transition to IADL dependence, which is less severe than ADL dependence, is evidence for the strong effects of smoking and drinking. As a result, efforts to reduce smoking and alcohol consumption are needed to reduce the risk of dependence.

The KLoSA survey has the great advantage of including a medical questionnaire completed by every adult household member older than 45 years in 2006. The study sheds light on the role played by pathologies on the onset to or recovery from dependence. No evidence was found on any effect of body mass with respect to dependence, contrary to expectation.[11] Better grip power and more points of cognition, as expected,[8] predict a lower risk of dependence for non-dependants. Depression[8] favors death, but not dependence. For cancer, diabetes, and liver diseases, difficulties often appear in the last weeks of life and are, therefore, not visible in the survey. Diabetes and hypertension have no significant effect because they are not direct factors of dependence, but cofactors for the advent of cardiovascular and neurovascular complications. Lung diseases have no significant coefficients in either transition. Psychiatric diseases are expected to favor

Table 3 – Logistic regression of the transition probabilities from 'difficulties in IADL'.

Variable	Tranistion to death		Recovery		Transition to more difficulties in IADL		Transition to difficulties in ADL	
	Coeff.	Std	Coeff.	Std	Coeff	Std	Coeff	Std
Constant	1.12*	0.62	1.55**	0.52	0.72	0.74	0.35	0.85
Man	0.21	0.26	−0.01	0.24	−0.19	0.37	0.08	0.61
45 ≤ age <58	Ref = 0		Ref = 0		Ref = 0		Ref = 0	
58 ≤ age <71	0.12	0.30	0.50**	0.22	−0.22	0.36	−1.16	1.24
71 ≤ age <82	0.32	0.36	0.44	0.30	0.36	0.42	0.01	0.41
82 ≤ age <93	1.28**	0.39	0.49	0.32	0.33	0.43	.	
Parity	0.30	0.40	−0.27	0.35	0.01	0.45	0.08	0.60
Income	8.04	8.53	0.07	7.37	−4.20	10.6	0.71	2.21
Retired	0.30	0.21	−0.01	0.18	0.21	0.25		
Receives no care	−0.67**	0.23	−0.56**	0.19	−0.25	0.28	−0.40	0.48
Can read & elementary school	Ref = 0		Ref = 0		Ref = 0		Ref = 0	
Middle and high school	0.20	0.29	0.03	0.25	0.07	0.39	0.33	0.58
College and postcollege	0.19	0.54	0.23	0.47	−0.06	0.79	−0.05	1.00
Metropolis	0.73**	0.33	0.72**	0.28	0.86**	0.41	−0.55	0.49
City	0.62	0.36	0.64**	0.31	0.22	0.46	−1.00	0.75
Town and rural	Ref = 0		Ref = 0		Ref = 0		Ref = 0	
Period 2010–2012	0.10	0.31	0.43	0.26	0.34	0.38	0.22	0.43
Period 2012–2014	0.08	0.29	0.47	0.29	0.30	0.31	0.29	0.45
Body mass index	−3.19	9.32	−14.3	8.28	−12.5	12.2	−1.61	1.22
Smoking	−0.23	0.21	−0.24	0.19	−0.21	0.27	0.15	0.49
Alcohol	0.75	0.46	0.58	0.41	−0.04	0.67	0.04	1.32
Depression	0.05	0.24	−0.35	0.21	−0.33	0.28	0.34	0.49
Points cognition	−0.09	0.44	−0.10	0.36	−0.68	0.45	−0.93	0.72
Grip power	−1.29	0.99	−0.35	0.83	0.30	1.18	−3.08	2.82
Arthritis	−0.17	0.32	−0.09	0.30	−0.08	0.39	0.23	0.52
Cancer	−0.05	0.56	−0.30	0.50	−0.68	0.92	0.95	1.07
Cardiac disease	−0.30	0.46	0.20	0.37	−0.05	0.46	−0.32	0.71
Cerebrovascular disease	−0.13	0.37	−0.25	0.29	0.03	0.41	−0.13	0.60
Diabetes	0.34	0.42	−0.08	0.38	−0.20	0.48	0.11	0.62
Hypertension	0.01	0.32	0.41	0.29	0.61	0.35	0.42	0.42
Liver disease	0.93**	0.45	.		0.57	.0.75	0.57	1.31
Lung disease	0.02	0.60	−0.09	0.64	−0.26	0.89	0.89	0.84
Prostatic disease	0.65	0.57	0.68	0.62	0.59	0.67	1.11	0.84
Psychiatric disease	−0.30	0.42	−0.09	0.34	0.23	0.51	0.54	0.66

N = 702 spells for 596 individuals. **: significant at 5%. Intraindividual dispersion: SD = 0.93** (0.08); for death, SD = 0.96** (0.19); for recovery, SD = 0.37** (0.07); for increase in IADL 1.06** (0.09); for transition into ADL 1.00** (0.10). Correlations between death and recovery −0.20 (0.20), between death and increase in ADL, 0.12 (0.14); between recovery and increase in IADL 0.12 (0.14), between increase in IADL and transition to difficulties in ADL 0.21 (0.36).
ADL, activities of daily living; IADL, instrumental activities of daily living; SD, standard devaition.

the onset of difficulties in IADL or ADL, but no coefficient appears significant. Prostatic diseases have no significant factors, because they lead either to cancer with a long period to death or to an adenoma which is not associated with dependence. Traffic accidents do not concern people with difficulties in ADL, who are limited in their capacity to use forms of transport, and those with difficulties in IADL only marginally.

The question on subjective health has a predictive power for the next wave. IADL dependence declared at the previous wave helps predict current IADL dependence. For ADL, the mortality rate is too high that this prediction from one wave to the other is irrelevant. We also found that caregiving favors recovery from IADL, as expected, and accompanies death. This is because in South Korea, caregiving is given to heavy dependence.

These results underline the need to organize the home and daily lives of dependants around physical (because of the effect of grip power we have shown) and intellectual activity (because of the effect of cognition we have shown) and to focus on the prevention of pathologies that play a significant role in the onset of dependence, notably diseases such as cardiac and cerebrovascular pathologies. The backed-up identification of the process leading to dependence contributes to progress on this social issue by establishing accurate transition rates and its determinants between the dependency statuses. Implications for practitioners are to know risk factors to dependence, after controlling for other variables and selection biases.

We went as far as possible in distinguishing dependency statuses. To the authors' knowledge, no studies have gone so far.

A first limitation is that we distinguished 'more difficulties' and 'fewer or the same number of difficulties' for dependants rather than each number of difficulty. This prevented us from

Table 4 – Logistic regression of the transition probabilities from 'difficulties in ADL'.

Variable	Transition to death		Recovery		Increases ADL	
	Coeff.	Std	Coeff.	Std	Coeff.	Std
Constant	0.12	2.21	1.19	1.96	−1.52	2.53
Man	0.04	1.19	0.28	1.09	−0.13	1.35
45 ≤ age <58	Ref = 0		Ref = 0		Ref = 0	
58 ≤ age <71	−0.41	1.71	−0.94	1.56	0.17	1.85
71 ≤ age < 82	−0.52	1.05	−0.57	0.89	−0.75	1.39
82 ≤ age <93	0.70	0.70	−0.98	2.10	−0.94	1.17
Nb of difficulties in ADL	0.25	0.42	0.44	0.42	0.61	0.46
Period 2010–2012	−0.77	1.45	−1.22	1.34	0.35	2.15
Period 2012–2014	−0.65	1.28	−0.92	1.04	0.30	1.98
Parity	0.18	1.60	0.78	1.50	−0.11	1.64
Income	−5.53	3.59	−23.7	32.6	−3.27	35.3
Retired	.		0.43	0.32	0.16	0.55
Receives no care	2.23	1.86	0.93	1.75	0.39	5.50
Can read & elementary school	Ref = 0		Ref = 0		Ref = 0	
Middle and high school +	−0.52	1.29	−0.39	1.16	−0.91	1.53
Metropolis	−0.98	1.71	−0.92	1.60	−0.60	1.41
City	−0.89	1.92	−0.88	1.87	−0.82	1.95
Town and rural	Ref = 0		Ref = 0		Ref = 0	
Body mass index	40.9	38.8	−5.58	35.4	15.9	46.0
Smoking	0.08	0.91	−0.06	0.82	−0.20	1.02
Depression	0.33	0.90	0.54	0.87	0.85	1.25
Points of cognition	0.98	2.02	0.74	1.95	1.32	2.19
Grip power	−2.20	8.97	−4.80	9.46	−3.16	12.8
Arthritis	1.06	0.96	0.82	0.88	.	
Cerebrovascular disease	0.13	1.21	−0.74	1.06	−0.05	1.64
Diabetes	0.40	1.37	1.00	1.36	−0.70	1.99
Hypertension	−1.12	1.23	−0.88	1.07	−0.86	1.60
Lung disease	−1.49	2.39	−0.67	1.96	−0.54	3.01
Prostatic disease (for men only)	1.09	2.56	0.82	2.51	.0.52	4.52
Psychiatric disease	0.79	2.56	0.60	1.63	0.15	2.13

N = 319 spells for 272 individuals. **: significant at 5%. Intraindividual dispersion: SD = 0.97** (0.19); for death, SD = 1.02** (0.16); for recovery, SD = 1.12** (0.30); for increase in ADL 0.90** (0.30). Correlations between death and recovery 0.09 (0.23), between death and increase in ADL, 0.04 (0.47); between recovery and increase in ADL -0.06 (0.23).
ADL, activities of daily living; IADL, instrumental activities of daily living; SD, standard devaition.

extending our analysis to infer a 'law' of deterioration. A second limitation is that the survey frame of two years between consecutive waves may conceal some transitions occurring within that interval.

In summary, in the transitions between dependence statuses, the KLoSA follow-up survey exploited with logit models proved to be detailed enough to make out socio-economic factors—gender inequality, age trend, residence, employment status—from medical ones: subjective health, smoking and alcohol consumption, grip power, score of cognition, cardiac and cerebrovascular diseases have significant predictive power for an impending onset of dependence. An important result is that mortality for dependants ceases to grow exponentially with age. This multifactorial analysis can serve as a guideline for effective interventions to reduce the risk of dependence.

Author statements

Ethical approval

None sought.

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Competing interests

The authors declare no conflict of interest.

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Appendix A. Supplementary data

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