

RIETI-JER Workshop

# Economics of Aging in Japan and other Societies

## Presentation



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# HOW INFORMAL CAREGIVERS' HEALTH AFFECTS RECIPIENTS

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## Brief Summary

- We empirically examine how informal caregivers' health affects the level of care provided.
- We use the individual dataset of the Japanese Study of Aging and Retirement (JSTAR) conducted by the Research Institute of Economy, Trade and Industry (RIETI), Hitotsubashi University, and the University of Tokyo.
- We find declining caregiver health adversely affects recipients of care.
  - This effect is evident outside genetic influences.

# Background

- In recent years, informal care provision has become increasingly important in countries that face population aging.
- **Advantages**
  - Within a family, informal care, typically by a child for their elderly parent, can suit the elderly's needs in their familiar home and environment.
  - Informal care can also help alleviate the financial burden of public-health and long-term care systems.
- **Disadvantages**
  - Informal care can burden the care providers, worsening their physical and psychological health, hampering their labor supply, or disrupting their leisure activities.

## Previous studies on informal care (1/2)

- **The relationship between informal and formal care provision.**
  - Pezzin et al., (1996 JHR), Van Houtven & Norton (2004 JHE, 2008 JHE), Hanaoka & Norton (2008 SSM), Bonsang (2009 JHE), Spillman & Long (2009 Inquiry), Tamiya et al., (2011 Lancet), Kikuchi (2012), Paraponaris et al., (2012 EJHE).
  - They find that informal care substitutes for formal care although the effects differ by situation.
- **Providing informal care negatively affects the caregiver's labor supply.**
  - Carmichael and Charles (1998 JHE, 2003 JHE), Pezzin & Schone, (1999 JHR), Noguchi & Shimizutani (2004), Carmichael et al., (2010 JHE), Hassink & Van den Berg (2011 SSM), Tamiya et al., (2011 Lancet), Otsu and Komamura (2012), Van Houtven et al., (2013 JHE).

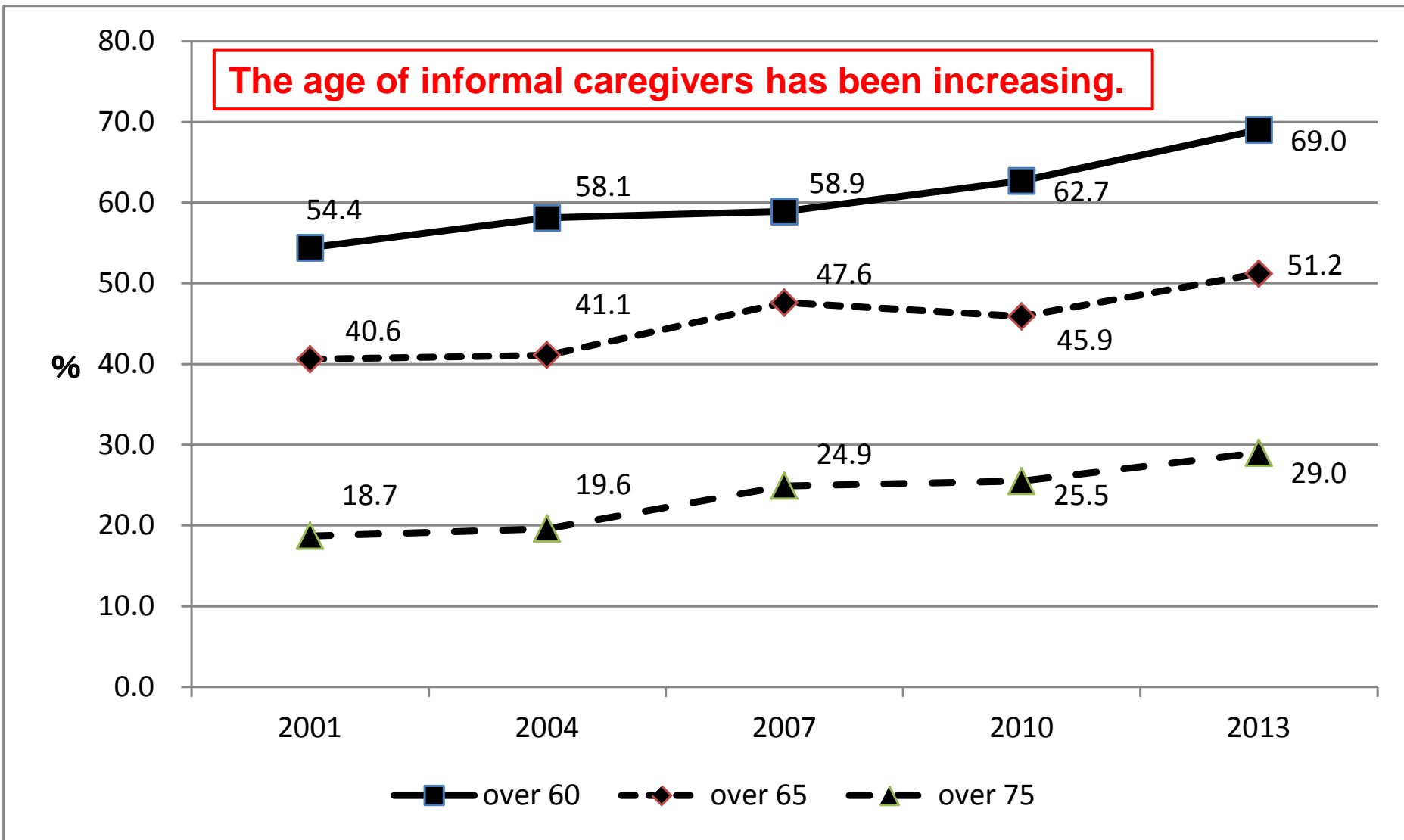
## Previous studies on informal care (2/2)

- Exploring who becomes a caregiver within a family.
  - Fontaine et al., (2009 HE), Pezzin et al., (2009 REH).
  - They find that economic conditions of siblings and the relationship between children and parents significantly affect this decision.
- Investigating the burden of family caregiving on caregiver's health condition
  - Kishida & Takagi (2007) and Suzuki et al., (2008 SER), Rubin & White-Means (2009 JFEI)
  - Caregiving adversely affects a caregiver's health (Kisida & Tanigaki (2007), Suzuki et al., (2008 SER)).
  - There is no significant effect (Rubin & White-Means (2009 JFEI)).

# Contributions

- These studies show how long-term care can affect caregiver behaviors **but give little attention to how changes in caregiver's circumstances ultimately affect those receiving care.**
- **Using the Japanese Study of Aging and Retirement (JSTAR).**
  - Japan is a critical setting for such research because of its rapid pace of population aging.
  - The elder-to-elder nursing care problem (**Fig.1**).
- **This analysis will provide useful insights to policy makers in other countries facing population aging.**

# Fig.1 Trends of the Main Caregiver's Age in a Household



Source: The Comprehensive Survey of Living Conditions in 2013, the Ministry of Health, Labour, and Welfare in Japan.



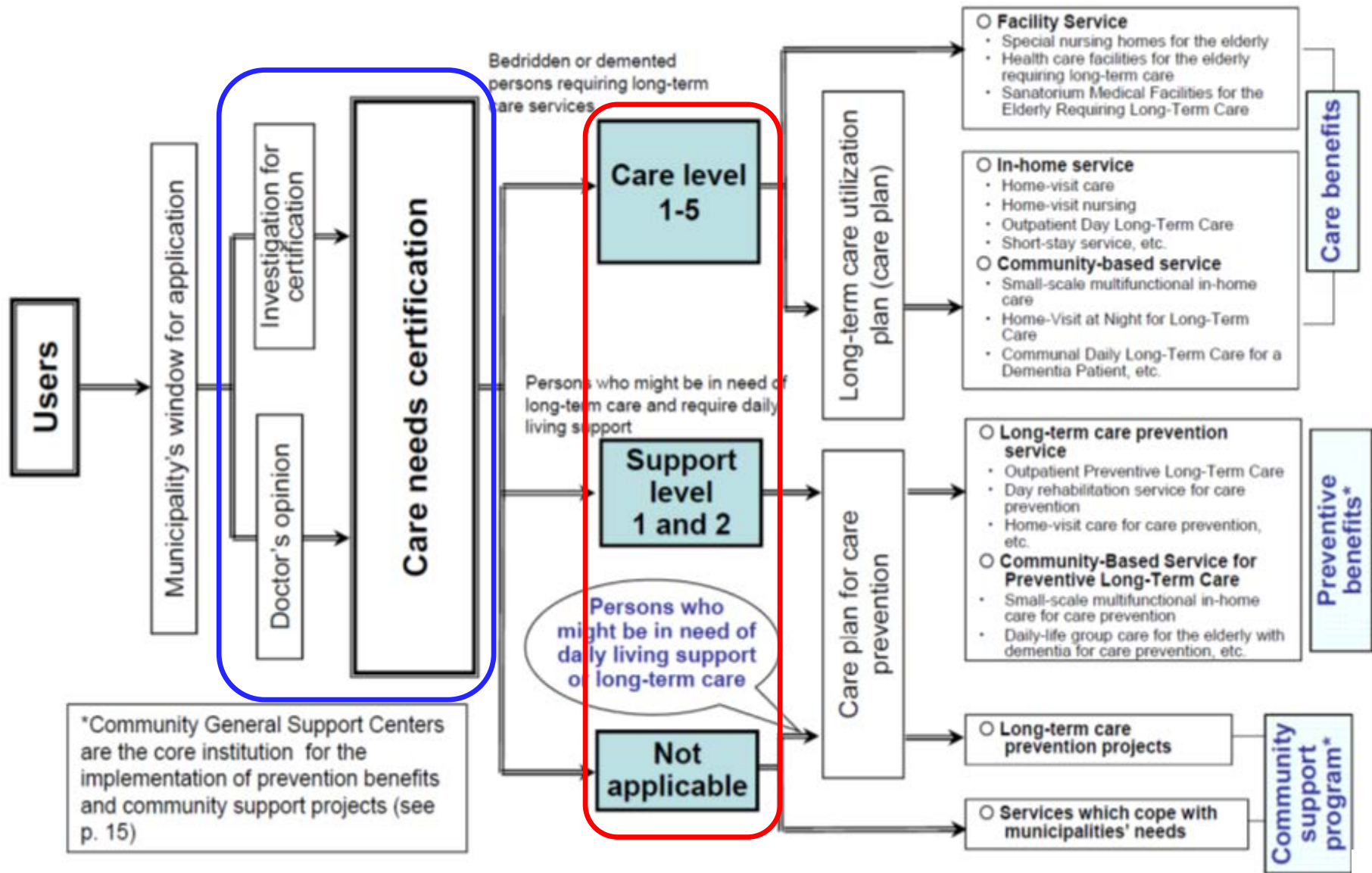
# Data

- **Japan Study of Aging and Retirement (JSTAR)**
  - A panel survey of elderly people aged 50 to 75 as randomly selected from the Basic Resident Register of the following 10 municipalities.
    - **2007-2011**: Adachi-Ku, Kanazawa City, Shirakawa City, Sendai City, and Takigawa City.
    - **2009-2011**: Tosu City and Naha City.
    - **2011**: Chofu City, Tonbayashi City, and Hiroshima City.
- The JSTAR collects information on health and socioeconomic characteristics of respondents and their family members through a self-completion questionnaire and a computer-assisted personal interview.

# Main Variables in the Empirical Analysis

- Target
  - The JSTAR respondents' still-living parents and parents-in-law at the first survey who are certified for specified care and support levels under the long-term care system.
- We examine the effect of caregiver's health on care receiver's care level.
  - Care receiver's Health Condition
    - **Elderly Care Receiver's Care Level.**
  - Caregiver's Health Conditions
    - **Subjective Self-reported Health Status.**
    - **The Number of Caregiver's Difficulty in Performing Daily Activities.**
    - **The Number of Caregiver's Chronic Diseases Diagnosed by a Doctor.**

# Fig 2. An Overview of the LTCI system in Japan



• Source: The Ministry of Health, Labour, and Welfare in Japan (2013, p10).

## Descriptive Statistics : Care Receiver

City	5 Municipalities							
Year	2007		2009		2011		Total	
	N	(%)	N	(%)	N	(%)	N	(%)
Not certified (= 0)	1167	71.0%	651	52.1%	220	45.1%	<b>2038</b>	<b>60.3%</b>
Certified for								
support level 1	43	2.6%	32	2.6%	11	2.3%	<b>86</b>	<b>2.5%</b>
support level 2	34	2.1%	40	3.2%	14	2.9%	<b>88</b>	<b>2.6%</b>
care level 1	56	3.4%	32	2.6%	16	3.3%	<b>104</b>	<b>3.1%</b>
care level 2	81	4.9%	59	4.7%	37	7.6%	<b>177</b>	<b>5.2%</b>
care level 3	87	5.3%	83	6.6%	38	7.8%	<b>208</b>	<b>6.2%</b>
care level 4	82	5.0%	74	5.9%	25	5.1%	<b>181</b>	<b>5.4%</b>
care level 5	94	5.7%	71	5.7%	36	7.4%	<b>201</b>	<b>5.9%</b>
Death (= 8)	0	0.0%	207	16.6%	91	18.6%	<b>298</b>	<b>8.8%</b>
Total	1644	100.0%	1249	100.0%	488	100.0%	<b>3381</b>	<b>100.0%</b>
Mean/ (SD)	1.331	(2.314)	2.767	(3.268)	3.186	(3.295)	<b>2.129</b>	<b>(2.955)</b>

City	2 Municipalities				3 Municipalities			
Year	2009		2011		Total		2011	
	N	(%)	N	(%)	N	(%)	N	(%)
Not certified (= 0)	320	64.4%	73	40.6%	<b>393</b>	<b>58.1%</b>	243	50.9%
Certified for								
support level 1	15	3.0%	4	2.2%	<b>19</b>	<b>2.8%</b>	15	3.1%
support level 2	20	4.0%	10	5.6%	<b>30</b>	<b>4.4%</b>	28	5.9%
care level 1	25	5.0%	7	3.9%	<b>32</b>	<b>4.7%</b>	41	8.6%
care level 2	23	4.6%	9	5.0%	<b>32</b>	<b>4.7%</b>	32	6.7%
care level 3	30	6.0%	12	6.7%	<b>42</b>	<b>6.2%</b>	37	7.8%
care level 4	22	4.4%	10	5.6%	<b>32</b>	<b>4.7%</b>	36	7.5%
care level 5	42	8.5%	18	10.0%	<b>60</b>	<b>8.9%</b>	45	9.4%
Death (= 8)	0	0.0%	37	20.6%	<b>37</b>	<b>5.5%</b>	0	0.0%
Total	497	100.0%	180	100.0%	<b>677</b>	<b>100.0%</b>	477	100.0%
Mean/ (SD)	1.606	(2.462)	3.461	(3.347)	<b>2.099</b>	<b>(2.843)</b>	2.176	(2.583)

- The question is *“Is your father/ mother/ spouse’s father/ spouse’s mother certified to receive care? If so, at what level of care? Please answer to the best of your ability.”*

# Main Variables in the Empirical Analysis

- Target
  - The JSTAR respondents' still-living parents and parents-in-law at the first survey who are certified for specified care and support levels under the long-term care system.
- We examine the effect of caregiver's health on care receiver's care level.
  - Care receiver's Health Condition
    - **Elderly Care Receiver's Care Level.**
  - Caregiver's Health Conditions
    - **Subjective Self-reported Health Status.**
    - **The Number of Caregiver's Difficulty in Performing Daily Activities.**
    - **The Number of Caregiver's Chronic Diseases Diagnosed by a Doctor.**

## Descriptive Statistics : Caregiver (Self-reported Subjective Health Status)

City	5 Municipalities							
Year	2007		2009		2011		Total	
	N	(%)	N	(%)	N	(%)	N	(%)
Very Good (= 0)	64	6.5%	43	5.7%	20	3.0%	<b>127</b>	<b>5.3%</b>
Good	206	21.0%	228	30.2%	210	32.0%	<b>644</b>	<b>26.9%</b>
Fair	623	63.6%	437	57.8%	370	56.4%	<b>1430</b>	<b>59.8%</b>
Bad	81	8.3%	44	5.8%	53	8.1%	<b>178</b>	<b>7.4%</b>
Very Bad (= 4)	5	0.5%	4	0.5%	3	0.5%	<b>12</b>	<b>0.5%</b>
Total	979	100.0%	756	100.0%	656	100.0%	<b>2391</b>	<b>100.0%</b>
Mean/ (SD)	1.752	(0.717)	1.653	(0.699)	1.709	(0.676)	<b>1.709</b>	<b>(0.701)</b>

City	2 Municipalities				3 Municipalities			
Year	2009		2011		Total		2011	
	N	(%)	N	(%)	N	(%)	N	(%)
Very Good (= 0)	25	8.7%	7	3.3%	<b>32</b>	<b>6.5%</b>	34	7.8%
Good	54	18.9%	73	34.8%	<b>127</b>	<b>25.6%</b>	97	22.2%
Fair	170	59.4%	106	50.5%	<b>276</b>	<b>55.6%</b>	262	60.0%
Bad	36	12.6%	21	10.0%	<b>57</b>	<b>11.5%</b>	41	9.4%
Very Bad (= 4)	1	0.3%	3	1.4%	<b>4</b>	<b>0.8%</b>	3	0.7%
Total	286	100.0%	210	100.0%	<b>496</b>	<b>100.0%</b>	437	100.0%
Mean/ (SD)	1.769	(0.792)	1.714	(0.748)	<b>1.746</b>	<b>(0.773)</b>	1.730	(0.763)

- The question is *“Please select the item that most accurately describes your overall current health. (Circle only one)”*.

# Descriptive Statistics : Caregiver

## (The Number of Caregiver's Difficulty in Performing Daily Activities)

City	5 Municipalities							
Year	2007		2009		2011		Total	
# of difficulties	N	(%)	N	(%)	N	(%)	N	(%)
0	894	87.0%	879	90.0%	571	83.4%	2344	87.1%
1	56	5.5%	41	4.2%	58	8.5%	155	5.8%
2	33	3.2%	18	1.8%	18	2.6%	69	2.6%
3	10	1.0%	10	1.0%	8	1.2%	28	1.0%
4	11	1.1%	10	1.0%	8	1.2%	29	1.1%
5	6	0.6%	6	0.6%	2	0.3%	14	0.5%
6	4	0.4%	4	0.4%	0	0.0%	8	0.3%
7	4	0.4%	2	0.2%	3	0.4%	9	0.3%
8	2	0.2%	1	0.1%	2	0.3%	5	0.2%
9	5	0.5%	2	0.2%	4	0.6%	11	0.4%
10	3	0.3%	4	0.4%	11	1.6%	18	0.7%
Total	1028	100.0%	977	100.0%	685	100.0%	2690	100.0%
Mean/ (SD)	0.359	(1.265)	0.288	(1.154)	0.501	(1.667)	0.369	(1.346)

City	2 Municipalities				3 Municipalities			
Year	2009		2011		Total		2011	
# of difficulties	N	(%)	N	(%)	N	(%)	N	(%)
0	279	84.0%	197	84.9%	476	84.4%	425	87.4%
1	29	8.7%	17	7.3%	46	8.2%	22	4.5%
2	7	2.1%	5	2.2%	12	2.1%	12	2.5%
3	6	1.8%	3	1.3%	9	1.6%	11	2.3%
4	5	1.5%	2	0.9%	7	1.2%	7	1.4%
5	3	0.9%	1	0.4%	4	0.7%	1	0.2%
6	1	0.3%	2	0.9%	3	0.5%	2	0.4%
7	0	0.0%	1	0.4%	1	0.2%	0	0.0%
8	0	0.0%	1	0.4%	1	0.2%	3	0.6%
9	1	0.3%	0	0.0%	1	0.2%	2	0.4%
10	1	0.3%	3	1.3%	4	0.7%	1	0.2%
Total	332	100.0%	232	100.0%	564	100.0%	486	100.0%
Mean/ (SD)	0.366	(1.152)	0.457	(1.554)	0.402	(1.331)	0.362	(1.259)

## Note: Definitions of *The difficulty in performing daily activities*

- Walk 100 meters.
- Sit in a chair for two hours continuously.
- Get up from a chair after sitting continuously for a long time.
- Climb up several flights of stairs without using the handrail.
- Climb up one flight of stairs without using the handrail.
- Squat or kneel.
- Raise your hands above your shoulders.
- Push or pull a large object such as a living-room chair or sofa.
- Lift and carry an object weighing 5kg or more, such as a bag of rice.
- Pick up a small object such as a one-yen coin from a desktop with your fingers.



## Descriptive Statistics : Caregiver (The Number of Caregiver's Chronic Diseases Diagnosed by a Doctor)

City	5 Municipalities							
Year	2007		2009		2011		Total	
# of diseases	N	(%)	N	(%)	N	(%)	N	(%)
0	369	35.9%	782	80.0%	545	79.6%	1696	63.0%
1	331	32.2%	151	15.5%	108	15.8%	590	21.9%
2	190	18.5%	35	3.6%	24	3.5%	249	9.3%
3	80	7.8%	7	0.7%	5	0.7%	92	3.4%
4	42	4.1%	1	0.1%	3	0.4%	46	1.7%
5	9	0.9%	0	0.0%	0	0.0%	9	0.3%
6	6	0.6%	1	0.1%	0	0.0%	7	0.3%
7	0	0.0%	0	0.0%	0	0.0%	0	0.0%
8	1	0.1%	0	0.0%	0	0.0%	1	0.0%
Total	1028	100.0%	977	100.0%	685	100.0%	2690	100.0%
Mean/ (SD)	1.175	(1.236)	0.258	(0.591)	0.267	(0.602)	0.611	(1.000)

City	2 Municipalities				3 Municipalities			
Year	2009		2011		Total		2011	
# of diseases	N	(%)	N	(%)	N	(%)	N	(%)
0	134	40.4%	198	85.3%	332	58.9%	218	44.9%
1	92	27.7%	24	10.3%	116	20.6%	104	21.4%
2	51	15.4%	9	3.9%	60	10.6%	81	16.7%
3	35	10.5%	0	0.0%	35	6.2%	43	8.8%
4	10	3.0%	1	0.4%	11	2.0%	20	4.1%
5	8	2.4%	0	0.0%	8	1.4%	14	2.9%
6	0	0.0%	0	0.0%	0	0.0%	4	0.8%
7	2	0.6%	0	0.0%	2	0.4%	2	0.4%
8	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total	332	100.0%	232	100.0%	564	100.0%	486	100.0%
Mean/ (SD)	1.184	(1.351)	0.198	(0.538)	0.778	(1.194)	1.200	(1.456)

## Note: Definitions of *The chronic diseases*

- Heart disease (angina, heart failure, cardiac infarction, valve disease, etc.)
- High blood pressure
- Hyperlipimia
- Cerebral accident
- Cerebrovascular accident
- Diabetes
- Chronic lung disease (chronic bronchitis, emphysema, etc.),
- Asthma
- Liver disease (hepatitis B or C, hepatic cirrhosis, etc. Not including liver cancer)
- Ulcer or other stomach disorder
- Joint disorder (Arthritis, rheumatism)
- Broken hip
- Osteoporosis
- Eye disease (Cataracts, glaucoma, etc.)
- Ear disorder (hard of hearing, etc.)
- Bladder disorder (incontinence, leakage, difficulty in urinating, enlarged prostate)
- Parkinson's Disease
- Depression and emotional disorder
- Dementia
- Skin disorder
- Cancer (including leukemia, lymphoma; not including benign skin cancer)
- Other.

# The Empirical Model (1/3)

- The care receiver's health production equation

$$H_{R_{it}}^* = \alpha_0 + \alpha_1 H_{Gm_{it}} + \mathbf{x}_{R_{it}} \boldsymbol{\alpha} + year_t + city_i + u_{R_{it}}$$

- **The Dependent Variable**

- $H_R^*$ : the level of care needs as certified by municipality.
  - 0 if *Not Applicable (Self-reliant)*.
  - 1 if *Support Levels 1 or 2*.
  - 2 if *Care Level 1*.
  - 3 if *Care Level 2*.
  - 4 if *Care Level 3, 4, or 5*.
    - Generally, the elderly with care level 3 or higher cannot do daily activities, even if someone supports or assists them.
  - 5 if *the care receiver passes away*.

## The Empirical Model (2/3)

- The care receiver's health production equation

$$H_{R_{it}}^* = \alpha_0 + \alpha_1 H_{G_{m_{it}}} + \mathbf{x}_{R_{it}} \boldsymbol{\alpha} + year_t + city_i + u_{R_{it}}$$

- **The Important Independent Variable**

- $H_{G_m}$ : the caregiver's health condition.
  - $H_{G_1}$ : subjective self-reported health status.
    - 0 = Very Good, 1 = Good, 2 = Fair, 3 = Bad, 4 = Very Bad.
  - $H_{G_2}$ : an index for caregiver's difficulty in performing daily activities.
    - 1 if the caregiver has more than one difficulty.
  - $H_{G_3}$ : an index for caregiver's chronic diseases diagnosed by a doctor.
    - 1 if the caregiver has more than one chronic disease.
- If  $\alpha_1 > 0$ , deterioration in the aged caregiver's health leads to worse care for those receiving it.

## The Empirical Model (3/3)

- The care receiver's health production equation

$$H_{R_{it}}^* = \alpha_0 + \alpha_1 H_{Gm_{it}} + \mathbf{x}_{R_{it}} \boldsymbol{\alpha} + year_t + city_i + u_{R_{it}}$$

- **Other Independent Variables**

- $\mathbf{x}_R$ : the care receiver's individual attributes.
  - Gender (1 = female)
  - Age and its squared
  - An indicator of nursing facility admission (1 = admitted)
- *year*: year fixed effect
- *city*: municipal fixed effect
- $u_R$ : an error term
  - $u_R \sim \phi(0, 1)$
  - $E[u_R|x] = 0$ , where x includes all regressors in equation (1).

# Endogenous Problem

- We should think that  $H_{Gm}$  are also endogenous.
  - This may make estimated parameters biased.
- Solution to this problem: Joint estimation

$$H_{R_{it}}^* = \alpha_0 + \alpha_1 H_{Gm_{it}}^* + \mathbf{x}_{R_{it}} \boldsymbol{\alpha} + year_t + city_i + u_{R_{it}}$$

$$H_{Gm_{it}}^* = \beta_0 + \boxed{\mathbf{x}_{G_{it}} \boldsymbol{\beta}} + \mathbf{x}_{R_{it}} \boldsymbol{\gamma} + year_t + city_i + u_{G_{it}}$$

- $\mathbf{x}_G$ : the caregiver's individual attributes = Instrumental variables
  - Gender (1 = female)/ Age and its squared/ years of education
  - marital status/ the number of dependent minors (aged 19 and under)
  - gross yearly (marital) income, the amount of (marital) assets.
  - an index for having financial support from another person besides one's spouse
  - [hours of informal care provision per day]
- $u_{R'}$  &  $u_G$  : error terms
  - $(u_{R'}, u_G) \sim \phi^2(0, 0, 1, 1, \rho)$
  - $E[u_{R'} | \mathbf{x}] = 0$  and  $E[u_G | \mathbf{z}] = 0$ ,

# Samples and Estimation method

- Samples
  - **Full sample**
    - respondents' still-living parents who have needed formal or informal care at the first survey.
      - But 23.1 percent of the parents do not receive care.
  - **Subsample**
    - respondents' still-living parents who do receive care.
      - We exclude 23.1 percent of the parents from the full sample.
- Estimation Method
  - **Ordered Probit (OP) model.**
  - **Bivariate Ordered Probit (BOP) model (Sajaya, 2008 SJ).**
  - **Standard Errors**
    - The clustering robust standard errors that allow for correlated residuals within families.

# Descriptive Statistics

Sample	Full sample				Subsample			
Endogenous variables	Mean	SD	Min	Max	Mean	SD	Min	Max
Care receiver's Care Level	1.408	1.878	0	5	1.812	1.952	0	5
Caregiver's Self-reported Health Status	1.712	0.713	0	4	1.716	0.720	0	4
Caregiver's Difficulty Performing (=1 if Yes)	0.122	0.327	0	1	0.131	0.338	0	1
Caregiver's Diseases Diagnosed by a Doctor (=1 if Yes)	0.441	0.497	0	1	0.448	0.497	0	1
<b>Care Receiver's Characteristics</b>								
Female	0.741	0.438	0	1	0.761	0.427	0	1
Age	86.578	6.508	59	105	87.746	6.295	59	105
Institutioned	0.208	0.406	0	1	0.268	0.443	0	1
<b>Caregiver's Characteristics</b>								
Female	0.483	0.500	0	1	0.488	0.500	0	1
Age	60.127	5.739	50	79	60.863	5.907	50	79
Years of Education	12.735	2.389	9	21	12.614	2.415	9	21
Marriage	0.903	0.296	0	1	0.881	0.323	0	1
Number of Dependents aged under 19	0.091	0.388	0	4	0.079	0.368	0	4
Income (10 million yen)	0.400	0.661	0	27.524	0.387	0.699	0	27.524
Financial Asset (10 million yen)	0.627	1.392	0	15.2	0.632	1.356	0	15.2
Financial Support (=1 if Yes)	0.105	0.307	0	1	0.106	0.308	0	1
Hours of Providing Informal Care per Day	0.435	1.369	0	24	0.463	1.388	0	24
Number of observations		4535				3524		
Number of Groups (Individuals)		2700				2075		
Number of Clusters (Families)		1582				1578		



# The Empirical Results (1/4): Full sample

Model	Ordered Probit			Bivariate Ordered Probit		
	$H_{G1}$	$H_{G2}$	$H_{G3}$	$H_{G1}$	$H_{G2}$	$H_{G3}$
Caregiver's Health Status	0.066 ** 0.026	-0.007 0.055	-0.019 0.039	0.436 0.363	0.196 ** 0.078	-0.053 0.191
Number of observations	4535	4535	4535	4535	4535	4535
Number of groups (individuils)	2700	2700	2700	2700	2700	2700
Number of clusters (families)	1582	1582	1582	1582	1582	1582
Log Likelihood	-5351.62	-5355.04	-5354.94	-10026.67	-6915.34	-8078.45
F/ Wald statistics: all coef. = 0	878.73 ***	872.80 ***	872.69 ***	44.37 ***	118.42 ***	352.71 ***
F/ Wald test: year effects = 0	388.61 ***	383.34 ***	298.44 ***	93.52 ***	345.24 ***	309.73 ***
F/ Wald test: local effects = 0	92.43 ***	91.38 ***	81.20 ***	85.07 ***	97.51 ***	188.67 ***
LR test: rho = 0				8.02 ***	1.99	0.18
First stage F-statistics				18.56 **	73.53 ***	44.96 ***
Test for overidentifying restrictions				3.65	2.31	4.41

- **Subjective self-reported health**
  - Positively significant in the OP model/ Insignificant in the BOP model.
- **The difficulty in performing daily activities**
  - Insignificant in the OP model/ Positively significant in the BOP model.
- **The chronic diseases**
  - Insignificant in the OP & BOP models.
- **The  $\rho$  of  $H_{G1}$  is significant/ Instruments are statistically valid.**

# The Empirical Results (2/4): Full sample

Model	Bivariate Ordered Probit			BOP model with hours of informal care per day		
	$H_{G1}$	$H_{G2}$	$H_{G3}$	$H_{G1}$	$H_{G2}$	$H_{G3}$
Caregiver's Health Status	0.436	0.196 **	-0.053	0.687	0.238 ***	0.024
	0.363	0.078	0.191	0.502	0.090	0.322
Number of observations	4535	4535	4535	4535	4535	4535
Number of groups (individuils)	2700	2700	2700	2700	2700	2700
Number of clusters (families)	1582	1582	1582	1582	1582	1582
Log Likelihood	-10026.67	-6915.34	-8078.45	-10025.15	-6912.90	-8078.06
F/ Wald statistics: all coef. = 0	44.37 ***	118.42 ***	352.71 ***	39.90 **	119.24 ***	355.43 ***
F/ Wald test: year effects = 0	93.52 ***	345.24 ***	309.73 ***	13.37 ***	318.56 ***	310.68 ***
F/ Wald test: local effects = 0	85.07 ***	97.51 ***	188.67 ***	49.54 ***	95.65 ***	190.61 ***
LR test: rho = 0	8.02 ***	1.99	0.18	11.74 ***	3.73 *	0.21
First stage F-statistics	18.56 **	73.53 ***	44.96 ***	14.70	71.34 ***	46.88 ***
Test for overidentifying restrictions	3.65	2.31	4.41	4.11	3.08	4.61

- **Subjective self-reported health**
  - Insignificant in the both BOP model.
- **The difficulty in performing daily activities**
  - Positively significant in the both BOP model.
- **The chronic diseases**
  - Insignificant in the both BOP model.
- **The  $\rho$ s of  $H_{G1}$  &  $H_{G2}$  are significant/ Instruments are statistically valid.**

# The Empirical Results (3/4): Subsample

Model	Ordered Probit			Bivariate Ordered Probit		
	$H_{G1}$	$H_{G2}$	$H_{G3}$	$H_{G1}$	$H_{G2}$	$H_{G3}$
Caregiver's Health Status	0.066 ** 0.028	-0.024 0.059	-0.036 0.043	-0.186 0.546	0.162 * 0.086	-0.237 0.232
Number of observations	3524	3524	3524	3524	3524	3524
Number of groups (individuils)	2075	2075	2075	2075	2075	2075
Number of clusters (families)	1578	1578	1578	1578	1578	1578
Log Likelihood	-4847.29	-4850.23	-4849.94	-8515.39	-6123.85	-6958.24
F/ Wald statistics: all coef. = 0	701.87 ***	693.96 ***	692.98 ***	53.72 ***	114.10 ***	351.54 ***
F/ Wald test: year effects = 0	478.17 ***	473.01 ***	365.03 ***	34.44 ***	421.38 ***	304.24 ***
F/ Wald test: local effects = 0	76.64 ***	75.75 ***	64.35 ***	73.30 ***	82.43 ***	188.44 ***
LR test: rho = 0				6.62 **	2.13	1.50
First stage F-statistics				24.39 ***	75.41 ***	39.62 ***
Test for overidentifying restrictions				4.93	2.74	4.92

- **Subjective self-reported health**
  - Positively significant in the OP model/ Insignificant in the BOP model.
- **The difficulty in performing daily activities**
  - Insignificant in the OP model/ Positively significant in the BOP model.
- **The chronic diseases**
  - Insignificant in the OP & BOP models.
- **The  $\rho$  of  $H_{G1}$  is significant/ Instruments are statistically valid.**

# The Empirical Results (4/4): Subsample

Model	Bivariate Ordered Probit			BOP model with hours of informal care per day		
	$H_{G1}$	$H_{G2}$	$H_{G3}$	$H_{G1}$	$H_{G2}$	$H_{G3}$
Caregiver's Health Status	-0.186 0.546	0.162 * 0.086	-0.237 0.232	-0.287 1.346	0.199 *** 0.089	-0.205 0.373
Number of observations	3524	3524	3524	3524	3524	3524
Number of groups (individuils)	2075	2075	2075	2075	2075	2075
Number of clusters (families)	1578	1578	1578	1578	1578	1578
Log Likelihood	-8515.39	-6123.85	-6958.24	-8515.32	-6120.71	-6958.19
F/ Wald statistics: all coef. = 0	53.72 ***	114.10 ***	351.54 ***	53.82 ***	114.91 ***	352.35 ***
F/ Wald test: year effects = 0	34.44 ***	421.38 ***	304.24 ***	14.99 ***	394.59 ***	305.28 ***
F/ Wald test: local effects = 0	73.30 ***	82.43 ***	188.44 ***	65.23 ***	82.00 ***	186.14 ***
LR test: rho = 0	6.62 **	2.13	1.50	6.06 **	3.28 *	1.32
First stage F-statistics	24.39 ***	75.41 ***	39.62 ***	23.97 ***	73.14 ***	41.01 ***
Test for overidentifying restrictions	4.93	2.74	4.92	5.25	3.54	5.71

- **Subjective self-reported health**
  - Insignificant in the both BOP model.
- **The difficulty in performing daily activities**
  - Positively significant in the both BOP model.
- **The chronic diseases**
  - Insignificant in the both BOP model.
- **The  $\rho$ s of  $H_{G1}$  &  $H_{G2}$  are significant/ Instruments are statistically valid.**

## Exclusion of Genetic Effect (1/5)

- **Genes can affect health and activities** (E.g., Conley, 2009 BSB; Cawley et al., 2011 HE, Cawley and Ruhm, 2012 HBHE).
  - The previous empirical results may reflect that health deterioration of both parents and adult children resulting from shared genetic characteristics.
- We remove genetic effects from our analysis by examining the effect of caregiver's health on the health of in-laws receiving care.

# Exclusion of Genetic Effect (2/5): Full sample

Model	Ordered Probit			Bivariate Ordered Probit		
	$H_{G1}$	$H_{G2}$	$H_{G3}$	$H_{G1}$	$H_{G2}$	$H_{G3}$
Caregiver's Health Status	0.079 *	0.156	0.057	0.671 ***	0.263	-0.078
	0.043	0.098	0.065	0.252	0.298	0.390
Number of observations	1738	1738	1738	1738	1738	1738
Number of groups (individuls)	1197	1197	1197	1197	1197	1197
Number of clusters (families)	972	972	972	972	972	972
Log Likelihood	-1874.58	-1875.01	-1875.97	-3656.52	-2422.35	-2940.55
F/ Wald statistics: all coef. = 0	395.83 ***	391.16 ***	397.28 ***	34.89 **	62.20 ***	179.85 ***
F/ Wald test: year effects = 0	175.10 ***	174.46 ***	143.77 ***	35.60 ***	164.47 ***	154.84 ***
F/ Wald test: local effects = 0	60.81 ***	62.65 ***	60.50 ***	41.50 ***	67.19 ***	83.20 ***
LR test: rho = 0				5.89 **	2.84 *	0.83
First stage F-statistics				14.86 *	27.18 ***	29.68 ***
Test for overidentifying restrictions				2.17	2.88	0.30

- **Subjective self-reported health**
  - Positively significant in the OP & BOP model.
- **The difficulty in performing daily activities**
  - Insignificant in the OP & BOP model.
- **The chronic diseases**
  - Insignificant in the OP & BOP model.
- **The  $\rho$ s of  $H_{G1}$  &  $H_{G2}$  are significant/ Instruments are statistically valid.**

# Exclusion of Genetic Effect (3/5) Full Sample

Model	Bivariate Ordered Probit			BOP model with hours of informal care per day		
	$H_{G1}$	$H_{G2}$	$H_{G3}$	$H_{G1}$	$H_{G2}$	$H_{G3}$
Caregiver's Health Status	0.671 *** 0.252	0.263 0.298	-0.078 0.390	0.696 *** 0.255	0.276 0.331	-0.060 0.446
Number of observations	1738	1738	1738	1738	1738	1738
Number of groups (individuls)	1197	1197	1197	1197	1197	1197
Number of clusters (families)	972	972	972	972	972	972
Log Likelihood	-3656.52	-2422.35	-2940.55	-3656.31	-2422.31	-2940.52
F/ Wald statistics: all coef. = 0	34.89 **	62.20 ***	179.85 ***	35.06 *	63.14 ***	180.40 ***
F/ Wald test: year effects = 0	35.60 ***	164.47 ***	154.84 ***	30.43 ***	165.88 ***	155.02 ***
F/ Wald test: local effects = 0	41.50 ***	67.19 ***	83.20 ***	37.81 ***	67.85 ***	83.16 ***
LR test: rho = 0	5.89 **	2.84 *	0.83	6.75 ***	2.98 *	0.76
First stage F-statistics	14.86 *	27.18 ***	29.68 ***	14.70 *	27.01 ***	29.98 ***
Test for overidentifying restrictions	2.17	2.88	0.30	2.24	2.62	3.34

- **Subjective self-reported health**
  - Positively significant in the both BOP model.
- **The difficulty in performing daily activities**
  - Insignificant in the both BOP model.
- **The chronic diseases**
  - Insignificant in the both BOP model.
- **The  $\rho$ s of  $H_{G1}$  &  $H_{G2}$  are significant/ Instruments are statistically valid.**

# Exclusion of Genetic Effect (4/5) Subsample

Model	Ordered Probit			Bivariate Ordered Probit		
	$H_{G1}$	$H_{G2}$	$H_{G3}$	$H_{G1}$	$H_{G2}$	$H_{G3}$
Caregiver's Health Status	0.082 *	0.119	0.098	0.904 ***	0.592 *	-0.632 **
	0.046	0.109	0.073	0.124	0.321	0.301
Number of observations	1215	1215	1215	1215	1215	1215
Number of groups (individuils)	840	840	840	840	840	840
Number of clusters (families)	765	765	765	765	765	765
Log Likelihood	-1621.31	-1622.20	-1621.95	-2860.58	-2038.26	-2349.39
F/ Wald statistics: all coef. = 0	314.03 ***	310.53 ***	311.04 ***	31.01 *	40.75 ***	174.37 ***
F/ Wald test: year effects = 0	222.87 ***	222.75 ***	184.16 ***	9.74 **	34.29 ***	131.69 ***
F/ Wald test: local effects = 0	59.21 ***	59.82 ***	59.12 ***	24.00 *	42.04 ***	66.50 ***
LR test: rho = 0				15.39 ***	7.93 ***	10.40 ***
First stage F-statistics				7.62	19.48 **	19.76 **
Test for overidentifying restrictions				3.74	3.72	3.76

- **Subjective self-reported health**
  - Positively significant in the OP & BOP model.
- **The difficulty in performing daily activities**
  - Insignificant in the OP model/ Positively significant in the BOP model.
- **The chronic diseases**
  - Insignificant in the OP model/ Negatively significant in the BOP model.
- **All  $\rho$ s are significant/ Most of instruments are statistically valid.**



# Exclusion of Genetic Effect (5/5) Subsample

Model	Bivariate Ordered Probit			BOP model with hours of informal care per day		
	$H_{G1}$	$H_{G2}$	$H_{G3}$	$H_{G1}$	$H_{G2}$	$H_{G3}$
Caregiver's Health Status	0.904 *** 0.124	0.592 * 0.321	-0.632 ** 0.301	0.902 *** 0.123	0.598 * 0.314	-0.636 ** 0.310
Number of observations	1215	1215	1215	1215	1215	1215
Number of groups (individuils)	840	840	840	840	840	840
Number of clusters (families)	765	765	765	765	765	765
Log Likelihood	-2860.58	-2038.26	-2349.39	-2860.21	-2037.99	-2349.38
F/ Wald statistics: all coef. = 0	31.01 *	40.75 ***	174.37 ***	31.25	41.15 **	174.60 ***
F/ Wald test: year effects = 0	9.74 **	34.29 ***	131.69 ***	10.09 **	33.43 ***	131.72 ***
F/ Wald test: local effects = 0	24.00 *	42.04 ***	66.50 ***	24.19 *	41.61 ***	66.52 ***
LR test: rho = 0	15.39 ***	7.93 ***	10.40 ***	15.42 ***	8.20 ***	10.38 ***
First stage F-statistics	7.62	19.48 **	19.76 **	7.94	19.26 **	20.45 **
Test for overidentifying restrictions	3.74	3.72	3.76	4.03	3.85	4.04

- **Subjective self-reported health**
  - Positively significant in the both BOP model.
- **The difficulty in performing daily activities**
  - Positively significant in the both BOP model.
- **The chronic diseases**
  - Negatively significant in the both BOP model.
- **All  $\rho$ s are significant/ Most of instruments are statistically valid.**

# Concluding Remarks

- We use the JSTAR to examine how informal caregivers' health affects the level of care provided.
- We find that deteriorating health for a caregiver adversely affects the health of the recipient, and that this effect persists even among individuals who are not genetically related.
- These results imply that creating circumstances that maintain middle-aged caregiver's good psychosomatic health conditions may also help maintain the health of care recipients.
  - This suggests policymakers should introduce aggressive health promotion and care prevention policies for middle-aged people.

# Limitations

- The JSTAR does not include detailed information on the parents' care utilization nor on expenditures for it.
- The JSTAR also does not have information on who is the primary caregiver nor on how much care each provider gives.
  - Several previous studies have shown that different types of long-term care services have different impacts on the health of those receiving care.
- Information on use of health care by elderly parents is unavailable in JSTAR.
  - Such information can help identify opportunities for cooperation in health and long-term care systems.
- Results from the JSTAR may not be generalized because the sample is not nationally representative.