How Informal Caregivers' Health Affects Recipients

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Abstract

Informal care is increasingly important in countries undergoing population aging. Previous research has discussed how the long-term care system may affect the behaviors of informal caregivers but has paid little attention to how changes in caregivers' circumstances affect those receiving their care. Using the Japanese Study of Aging and Retirement, we empirically examine how caregivers' health condition may affect the elderly parents receiving their care, and find that declining caregiver health adversely affects recipients of care. This effect is evident outside genetic influences.

Keywords: informal caregiver, elderly care receiver, health condition, long-term care, Japan

JEL Classification Number: I10, I12, J14

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1. Introduction

In recent years, informal care provision has become increasingly important in countries that face population aging. 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. While informal care can help alleviate the financial burden of public-health and long-term care systems, it 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 tend to focus on the following four areas. First, several studies have examined the relationship between informal and formal care provision (Pezzin et al.,

1996; Van Houtven and Norton, 2004 and 2008; Hanaoka and Norton, 2008; Bonsang, 2009; Spillman and Long, 2009; Tamiya et al., 2011; Kikuchi, 2012; Paraponaris et al., 2012). They find that informal care substitutes for formal care although the effects differ by situation. Second, much previous research has established that providing informal care negatively affects the caregiver's labor supply (Carmichael and Charles, 1998 and 2003; Pezzin and Schone, 1999; Noguchi and Shimizutani, 2004; Carmichael et al., 2010; Hassink and Van den Berg, 2011; Tamiya et al., 2011; Otsu and Komamura, 2012; Van Houtven et al., 2013). Third, previous research has explored who becomes a caregiver within a family (Fontaine et al., 2009; Pezzin et al., 2009), finding that economic conditions of siblings and the relationship between children and parents significantly affect this decision. Fourth, previous work has investigated the burden of family caregiving on caregiver's health condition, mainly using cross-sectional data. Two of these studies (Kishida and Takagi, 2007, and Suzuki et al., 2008) find that caregiving adversely affects a caregiver's health, but Rubin and White-Means (2009) find no significant effect.

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. Informal care, can, as noted, provide several benefits to those receiving it, as well as to the finances of long-term care systems. Yet such advantages may put burdens on caregivers and may ultimately

affect those receiving care. Researchers and policymakers should account for such burdens and their effects in estimating the costs and benefits of informal care giving.

In this article, we use the Japanese Study of Aging and Retirement (JSTAR) to empirically examine how burdens placed on caregivers may ultimately affect those receiving informal care. Japan is a critical setting for such research because of its rapid pace of population aging. As Figure 1 shows, the age of informal caregivers has been increasing: the proportion who are at least 60 years of age has increased from 54.4 percent in 2001 to 69.0 percent in 2013, while the proportion of those at least 75 years of age increased from 18.7 percent in 2001 to 29.0 percent in 2013. This elder-to-elder nursing care may worsen caregiver's health, with recent headlines on tragic cases of family suicide driven by the heavy burden of caregiving.

<Figure 1>

Investigating the care-giving burden on care-givers' health and subsequent consequences for care recipients can illuminate a serious social issue in Japan and provide useful insights to policy makers in other countries facing population aging. Our results indeed show that worsening health among informal caregivers adversely affects the health of those receiving their care. We see such

links between informal caregivers and their in-laws, demonstrating that these effects go beyond genetic influences.

In the next section, we provide a brief policy background with the overview of the Japanese long-term care insurance system. In Section 3, we discuss details of the data we use. In Sections 4 and 5, we review methods and present empirical results. In Section 6 we conclude.

2. Policy Background

Japan introduced its long-term care insurance (LTCI) system in April 2000 to support independent living for the elderly and decrease burden on family members who provide caregiving[1]. The insurer of the LTCI is each municipality[2], and the prefectural and national governments also support their finance and management. LTCI is compulsory for all persons at least 40 years of age, who pay earnings-related premiums. The primary insured are those at least 65 years of age, and the secondary insured are those 40 to 64 years of age. Figure 2 summarizes the decision process for

[1] National Institute of Population and Social Security Research (2014, Ch5) reviews the Japanese LTCI system in more detail. Tamiya et al. (2011) summarize the background of the LTCI, how it compares to similar systems in other countries, and policy challenges in the current system.

[2] Several small municipalities organize an extended association as a regional insurer for their financial stability and administrative efficiency.

choosing a level of care for long-term services. Persons 65 or older or those 40 to 64 with qualifying illnesses[3] requiring long-term care (e.g., because they are bedridden or have dementia) or support (e.g., because they are infirm) can apply for LTCI benefits. Care level, severity of their care need, is objectively determined by a computer program and a doctor's opinion, with those qualifying receiving long-term care and preventive benefits tailored to their circumstances. Recipients have a copayment of 10% of the cost[4], and the remaining 90% is split evenly between premiums and other public funds.

<Figure 2>

The number of certified persons increased from 2.2 million in 2000 to 5.3 million in 2012. Growth in the number of recipients has been particularly great at lower care levels. Total LTCI cost

[3] Qualifying illnesses are illnesses caused by physical and mental changes due to aging. In the current system, these are: terminal cancer, articular rheumatism, amyotrophic lateral sclerosis, ossification of the posterior longitudinal ligament, osteoporosis with fracture, premature dementia, progressive supranuclear palsy, corticobasal degeneration, and Parkinson's disease, spinocerebellar degeneration, spinal canal stenosis, progeria, multiple system atrophy, diabetic neuropathy, diabetic nephropathy, diabetic retinopathy, cerebrovascular disease, arteriosclerosis obliterans, chronic obstructive pulmonary disease, osteoarthritis with significant deformation of knee joints or hip joints.

[4] The Long-term Care Insurance Act determines the upper limit of the benefits. Benefits depend on the receiver's care level for home-care services and on the type and scale of the facility for facility-care services.

has also increased from 362 million yen in 2000 to a budgeted 892 million yen in 2012. In order to alleviate fiscal burden and to make the system more efficient, policymakers have sought several reforms. These included preventive-care benefits, introduced in 2005, that seek to increase healthy life expectancy though prevention of severe disability. Yuda et al. (2013) find that these preventative-care benefits maintain or improve the level of care for the elderly. The LTCI law was revised in 2008 to prevent devious activities of care providers such as non-observance of the law or submission of bogus claims. The law was revised again in 2012 to develop locally comprehensive systems for health and long-term care, prevention, residence, and livelihood support.

3. Data

To assess how circumstances of informal caregivers affect those for whom they care, we use data from the Japan Study of Aging and Retirement (JSTAR). The JSTAR is a panel survey of elderly people conducted by the Research Institute of Economy, Trade and Industry (RIETI), Hitotsubashi University, and the University of Tokyo. 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[5]. It is comparable to other Health and Retirement Study (HRS) family surveys, including the HRS in the United States, the Survey of Health, Aging and Retirement in Europe (SHARE), and the English Longitudinal Study of Aging (ELSA) in the United Kingdom[6]. The JSTAR sampled five municipalities in 2007, which have been surveyed every two years since then, an additional two municipalities in 2009, and an additional three, bringing the total to ten municipalities, in 2011. Its respondents are persons aged 50 to 75 as randomly selected from the Basic Resident Register[7]. The first five municipalities include Adachi-Ku, Kanazawa City, Shirakawa City, Sendai City, and Takigawa City (N=4,163 in 2007 with 82 – 87% retention rate in the follow-up waves in 2009 and 2011). The two municipalities added in 2009 includes Tosu City and Naha City (N=1567 in 2009 with 70% retention rate), and the three municipalities added in 2011 includes Chofu City, Tonbayashi City, and Hiroshima City (N=2,184). The baseline response rates for all municipalities range from

[5] The RIETI provides three types of JSTAR data for analysis. These differ by security level: High (H), Very High (VH), and Ultra High (UH). We use the Level VH JSTAR datasets. These contain the full sample datasets with geographic information. For more detailed information on the analysis data sets and how they differ by levels of security, see http://www.rieti.go.jp/en/projects/jstar/.

[6] See Ichimura, Shimizutani, and Hashimoto (2009) as well as the more recent and detailed information is available on the website of the *GATEWAY TO GLOBAL AGING DATA* (http://gateway.usc.edu).

[7] This sampling method differs from those of the HRS, the SHARE, and the ELSA. The JSTAR uses its sampling strategy so as to allow analysts to compare economic activities of individuals under the same circumstance.

48.5% to 52.2%.

Table 1 shows the number of JSTAR respondents' still-living parents and parents-in-law certified for specified care and support levels under the long-term care system[8,9]. The proportion of them certified for care in the five core JSTAR municipalities increased from 29.0% to 36.3% across the three years of the survey. Similar increases are observed in the two-year panel data for the two municipalities to which the JSTAR was expanded in 2009.

<Table 1>

Table 2 summarizes health conditions of the JSTAR respondents who provide care for family members. Panel (A) shows the caregiver's self-reported health. Although less than 10 percent of the respondents reported bad or very bad health in the five core municipalities, while in the other municipalities, more than 10 percent of caregiving respondents say their health is bad or very bad. Panel (B) shows the number of difficulties that informal caregivers in the core municipalities had in performing daily activities, including the proportion of those reporting any

[8] Figure 2 provides an overview of care and support levels.

[9] Because of troubles with survey equipment, questions regarding informal care in 2011 include only those for the respondent's parents and not the respondent's in-laws.

difficulties and the mean number of difficulties reported. These were greater in 2011 than in earlier years. In contrast, panel (C) shows chronic diseases for caregivers and the mean number of difficulties reported were quite lower in 2011 than in the first years.

<Table 2(A) - (C)>

4. Empirical Models

To examine how caregiver health may affect the health of those receiving care, we specify the following model (the care receiver's health production equation).

$$H^*_{R_{it}} = \alpha_0 + \alpha_1 H_{Gm_{it}} + \mathbf{x}_{\mathbf{R_{it}}}\boldsymbol{\alpha} + year_t + city_i + u_{R_{it}} \quad (1)$$

H_R^* is a latent variable of H_R, and H_R is an ordinal variable that represents the level of care needs as certified by municipality. H_R equals 0 if a care receiver is certified "Not applicable (self-reliant)" , 1 if the care level is "support levels 1 or 2", 2 if the care level is "care level 1", 3 if "care level 2", and 4 if "care level 3, 4, or 5"[10]. H_R is 5 if the care receiver passes away. We define $H_R = j$ if $\mu_{j-1} < H_R^* \leq$

[10] Generally, the elderly with care level 3 or higher cannot do daily activities, even if someone supports or assists them.

μ_j for $j = 0, \ldots 5$, where $\mu_0 = -\infty$ and $\mu_5 = \infty$.

H_{Gm} represents the caregiver's health condition. We employ three proxy variables for the caregiver's health condition: subjective self-reported health status (H_{G1}), an index for caregiver's difficulty in performing daily activities (H_{G2}), and an index for caregiver's chronic diseases diagnosed by a doctor (H_{G3}). H_{G1} is an ordinal variable which ranges from zero ("Very Good") to four ("Very Bad"). H_{G2} equals one if the caregiver has more than one difficulty, and H_{G3} equals one if the caregiver has more than one chronic disease[11]. α_1 is estimated to be positive when deterioration in the aged caregiver's health leads to worse care for those receiving it.

$\mathbf{x_R}$ is a vector of attributes for those receiving care that contains gender (a female dummy), age and its squares, and an indicator of nursing facility admission. Because female life expectancy is generally longer than that for males, we expect the coefficient for the female dummy variable to be positive. We also estimate care level to increase with age. We add a dummy variable for nursing-facility admission because care levels for institutionalized individuals are generally higher than those for other elderly and because the relationships of institutionalized individuals with their caregivers differ from those that non-institutionalized elderly have with their caregivers. *year* is a year fixed effect and *city* is a municipal fixed effect. u_R is an error term that we assume to be

[11] Although the empirical results are quite similar when the original ordinal variables of the number of difficulties and chronic diseases are used (see Tables 2(B) and 3(C)), likelihood functions do not converge.

exogenous (i.e., $E[u_R|\mathbf{x}] = 0$, where **x** includes all regressors in equation (1)).

Because the caregiver's health-status variables are also endogenous, estimated parameters may be biased. To solve this endogeneity problem, we define the caregiver's health production equation and jointly estimate the following equations (2) and (3).

$$H^*_{R_{it}} = \alpha_0 + \alpha_1 H^*_{Gm_{it}} + \mathbf{x}_{\mathbf{R_{it}}}\boldsymbol{\alpha} + year_t + city_i + u_{R'_{it}} \quad (2)$$

$$H^*_{Gm_{it}} = \beta_0 + \mathbf{x}_{\mathbf{G_{it}}}\boldsymbol{\beta} + \mathbf{x}_{\mathbf{R_{it}}}\boldsymbol{\gamma} + year_t + city_i + u_{G_{it}} \quad (3)$$

where $H_{Gm}{}^*$ is a latent variable of H_{Gm}, and $H_{G1} = j$ if $\lambda_{j-1} \leq H_{G1}{}^* < \lambda_j$ for $j = 0, \ldots, 4$ where $\lambda_0 = -\infty$ and $\lambda_4 = \infty$, $H_{G2} = 0$ if $H_{G2}{}^* \leq 0$ and $H_{G2} = 1$ if $H_{G2}{}^* > 0$, and $H_{G3} = 0$ if $H_{G3}{}^* \leq 0$ and $H_{G3} = 1$ if $H_{G3}{}^* > 0$. $\mathbf{x_G}$ is a vector of caregiver attributes that contains gender (a female dummy), age and its squares, years of education, marital status, the number of dependent minors (aged 19 and under), gross yearly (marital) income, the amount of (marital) assets, and an index for having financial support from another person besides one's spouse. $u_{R'}$ and u_G are error terms. We assume that each error term is exogenous ($E[u_{R'}|\mathbf{x}] = 0$ and $E[u_G|\mathbf{z}] = 0$, **x** includes all regressors in equations (2) and and **z** includes all regressors in equation (3)).

Because the burden of informal care provision may adversely affect the caregiver's health,

we also estimate equation (3) that includes the hours of informal care provision per day in $\mathbf{x_G}$. Hours of informal care provision is subject to caregiver's time constraints, which means this variable may be endogenous. Nevertheless, we assume that this variable is exogenous because the econometric model may become too complicated to be estimated.

Because dependent variables are ordinal, we estimate these equations by ordered probit (OP) model and bivariate ordered probit (BOP) model (Sajaya, 2008). We assume that u_R has a standard normal distribution ($u_R \sim \phi(0, 1)$) and $u_{R'}$ and u_G are distributed as bivariate standard normal with correlation of ρ ($(u_{R'}, u_G) \sim \phi^2(0, 0, 1, 1, \rho)$). The structure of the BOP model reveals that equation (3) assumes the role of the first stage regression with instrumental variables of $\mathbf{x_G}$. To consider family effects, we also estimate the clustering robust standard errors that allow for correlated residuals within families.

We analyze respondents' parents who have needed formal or informal care during the study period (full sample). Table 3 presents summary statistics for this population. The level of care they receive is relatively low (at the support level of 1.4). These care recipients are 74.1 percent female and have an average age of 86.6. The subjective health of the respondent caregiveers is basically good although 12.2 percent reported difficulties with activities of daily living and 44.1 percent reported chronic diseases. Caregivers are 48.3 percent female and have an average age of 60.1 years.

90.3 percent of them are married, and 9 percent of them live with dependent minors. Their mean gross yearly income is 4 million yen and their mean amount of assets is 6.27 million yen, while 10.5 percent of them receive financial support from persons other than their spouse. On average, they provide 0.435 hours of informal care daily. Because 23.1 percent of the parents do not receive care, we also estimated the same models above on the 76.9 percent of parents who do receive care (subsample).

<Table 3>

5. Empirical Results

5.1 Basic Results

Table 4 shows the empirical results using the full sample. The results of the OP model are summarized in the left side, those of the BOP model in the middle, and those of the BOP model with the hours of informal care provision per day in $\mathbf{x}_G$ in the right side[12].

The results of two test statistics for the validity of the instruments suggest that they are

[12] Most of results estimated by the liner probability models are closely similar to those of OP and BOP models.

statistically valid (e.g., Wooldridge, 2010). More specifically, the first stage F statistics exceed 10, while one of them is insignificant. This indicates that they have sufficient power for explaining caregiver's health. Regarding the overidentifying restrictions test, we cannot reject the null hypothesis that instruments are exogenous, which indicates that the instruments are not correlated with u_R,[13].

We find the caregiver's subjective self-reported health significantly and positively affects the recipient's level of care in the OP model but is insignificant in the BOP models. In addition, the recipient's level of care significantly increases when a caregiver has difficulty in performing daily activities in the BOP models. Because the LR tests in these models show that two error terms are correlated, the results of these BOP models are more reliable than those of the OP models. Yet caregiver's chronic diseases do not have a significant effect on the recipient's care level in the OP and BOP models, while the coefficients of female and nursing facility admission dummy variables are significantly positive.

Regarding the results of the first-stage regression, we note that increasing caregiver's age and having a spouse have significantly positive effects on the caregiver's subjective health status. Although female or aged caregivers tend to have more difficulty in performing daily activities,

[13] These statistics are based on the results of panel linear 2SLS estimation.

having more education or being married significantly decreases this probability. An increase in gross income has a significantly positive effect on the probability of a caregiver having chronic diseases. The coefficient of the number of dependent minors has an insignificant effect, consistent with the results of Rubin and White-Means (2009) comparing informal care provisions between the "sandwiched person", who takes care of both children and parents, and other caregivers. The coefficients of the hours of informal care provision per day are not significant, contradicting earlier work.

<Table 4>

Table 5 shows the empirical results using the subsample. Most of the results are consistent with those of the full sample. In particular, the results of two test statistics for the validity of the instruments suggest that they are statistically valid.

In this subsample, too, caregiver's subjective self-reported health significantly and positively affects level of care for the recipient in the OP model but is insignificant in the BOP models. In addition, in the BOP models recipient's level of care significantly increases when a caregiver has difficulty in performing daily activities. The LR tests in these models also show that

two error terms are correlated, which means that the results of these BOP model are more reliable than those of the OP model. Chronic disease for a caregiver does not significantly affect the level of care in the OP and BOP models. The coefficients for the dummy variable on nursing-facility admission are significantly positive.

Regarding the results of the first stage regression, older or married caregivers tend to be in good health. Increased assets also improve subjective health for caregivers, but greater income increases the probability of having chronic diseases. Female or aged caregivers are also more likely to report difficulty in performing daily activities, as does a greater number of hours providing daily care. The number of dependent minors does not affect caregiver's health.

<Table 5>

5.2 Exclusion of Genetic Effect

Because genes can affect health and activities (E.g., Conley, 2009; Cawley et al., 2011, Cawley and Ruhm, 2012), the empirical results in the previous subsection may reflect that health deterioration of both parents and adult children resulting from shared genetic characteristics. In this subsection, we remove genetic effects from our analysis by examining the effect of caregiver's

health on the health of in-laws receiving care.

Table 6 (A) shows the results using the full sample and Table 6 (B) shows the results for the subsample. Most of the results including the tests for the validity of instruments are consistent with those of the previous subsection. More specifically, worsening health for a caregiver adversely affects the health of an in-law care recipient. The results using the full sample show that deterioration of a caregiver's self-reported health can also adversely affect health of the care recipient in the OP and the BOP models, but other health statuses do not affect the level of care given. In addition, the LR tests in the model of self-reported health only show that two error terms are correlated. The results using the subsample, however, show that level of care does deteriorate with the caregiver's subjective self-reported health in both the OP and the BOP models. Caregiver's difficulty in performing daily activities does not have a significant effect on level of care in the OP model but does in the BOP models. Chronic disease of caregivers does not have a significant effect on the level of care in the OP model but does in the BOP models. In addition, the LR tests show that two error terms are correlated.

<Table 6 (A) & (B)>

6. Concluding Remarks

In this article, 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. Although some such policies have already been implemented in Japan as part of the national health screening and intervention program in 2008[14], it is important to discuss and establish more such comprehensive health policies in the future. Such policies, by ultimately strengthening the informal care system, may also help improve LTCI finances.

Our work has some limitations. The JSTAR does not include detailed information on the parents' care utilization nor on expenditures for it. It also does not have information on who is the primary caregiver nor on how much care each provider gives. Given several previous studies

[14] The national health screening and intervention program targets individuals aged 40 to 74 to prevent them at a risk of lifestyle-related diseases through focusing on metabolic syndrome. See Kohro et al., (2008) for more detailed explanation.

showing that different types of long-term care services have different impacts on the health of those receiving care, future research should identify these different sources and examine their effects. In addition, 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. Finally, results from the JSTAR may not be generalized because the sample is not nationally representative. Further analyses using other, nationally representative data would help confirm our findings.

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Table 1 Trends of Elderly Care Receiver's Care Level

City	5 Municipalities							
Year	2007		2009		2011		**Total**	
Care Level	N	(%)	N	(%)	N	(%)	**N**	**(%)**
Not applicable (self-reliant) (= 0)	1167	71.0%	651	52.1%	220	45.1%	**2038**	**60.3%**
Certified for support level 1 (= 1)	43	2.6%	32	2.6%	11	2.3%	**86**	**2.5%**
support level 2 (= 2)	34	2.1%	40	3.2%	14	2.9%	**88**	**2.6%**
care level 1 (= 3)	56	3.4%	32	2.6%	16	3.3%	**104**	**3.1%**
care level 2 (= 4)	81	4.9%	59	4.7%	37	7.6%	**177**	**5.2%**
care level 3 (= 5)	87	5.3%	83	6.6%	38	7.8%	**208**	**6.2%**
care level 4 (= 6)	82	5.0%	74	5.9%	25	5.1%	**181**	**5.4%**
care level 5 (= 7)	94	5.7%	71	5.7%	36	7.4%	**201**	**5.9%**
Death (= 8)	0	0.0%	207	16.6%	91	18.6%	**298**	**8.8%**
Total	1644	100.0%	1249	100.0%	488	100.0%	**3381**	**100.0%**
Mean/ (SD)	1.331	(2.314)	2.767	(3.268)	3.186	(3.295)	**2.129**	**(2.955)**

City	2 Municipalities						3 Municipalities	
Year	2009		2011		**Total**		2011	
Care Level	N	(%)	N	(%)	**N**	**(%)**	N	(%)
Not applicable (self-reliant) (= 0)	320	64.4%	73	40.6%	**393**	**58.1%**	243	50.9%
Certified for support level 1 (= 1)	15	3.0%	4	2.2%	**19**	**2.8%**	15	3.1%
support level 2 (= 2)	20	4.0%	10	5.6%	**30**	**4.4%**	28	5.9%

	care level 1 (= 3)	25	5.0%	7	3.9%	**32**	**4.7%**	41	8.6%
	care level 2 (= 4)	23	4.6%	9	5.0%	**32**	**4.7%**	32	6.7%
	care level 3 (= 5)	30	6.0%	12	6.7%	**42**	**6.2%**	37	7.8%
	care level 4 (= 6)	22	4.4%	10	5.6%	**32**	**4.7%**	36	7.5%
	care level 5 (= 7)	42	8.5%	18	10.0%	**60**	**8.9%**	45	9.4%
Death (= 8)		0	0.0%	37	20.6%	**37**	**5.5%**	0	0.0%
Total		497	100.0%	180	100.0%	**677**	**100.0%**	477	100.0%
Mean/ (SD)		1.606	(2.462)	3.461	(3.347)	**2.099**	**(2.843)**	2.176	(2.583)

Note: (1) 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.”

Table 2 The Trends of Health Conditions of the JSTAR Respondents Who Provide Care for Family Members

(A) Subjective Self-reported Health Status

City	5 Municipalities							
Year	2007		2009		2011		**Total**	
Self-reported Health	N	(%)	N	(%)	N	(%)	**N**	**(%)**
Very Good (= 0)	64	6.5%	43	5.7%	20	3.0%	**127**	**5.3%**
Good (= 1)	206	21.0%	228	30.2%	210	32.0%	**644**	**26.9%**
Fair (= 2)	623	63.6%	437	57.8%	370	56.4%	**1430**	**59.8%**
Bad (= 3)	81	8.3%	44	5.8%	53	8.1%	**178**	**7.4%**
Very Bad (= 4)	5	0.5%	4	0.5%	3	0.5%	**12**	**0.5%**
Total	979	100.0%	756	100.0%	656	100.0%	**2391**	**100.0%**
Mean/ (SD)	1.752	(0.717)	1.653	(0.699)	1.709	(0.676)	**1.709**	**(0.701)**

City	2 Municipalities						3 Municipalities	
Year	2009		2011		**Total**		2011	
Self-reported Health	N	(%)	N	(%)	**N**	**(%)**	N	(%)
Very Good (= 0)	25	8.7%	7	3.3%	**32**	**6.5%**	34	7.8%
Good (= 1)	54	18.9%	73	34.8%	**127**	**25.6%**	97	22.2%
Fair (= 2)	170	59.4%	106	50.5%	**276**	**55.6%**	262	60.0%
Bad (= 3)	36	12.6%	21	10.0%	**57**	**11.5%**	41	9.4%
Very Bad (= 4)	1	0.3%	3	1.4%	**4**	**0.8%**	3	0.7%
Total	286	100.0%	210	100.0%	**496**	**100.0%**	437	100.0%

Mean/ (SD)	1.769	(0.792)	1.714	(0.748)	**1.746**	**(0.773)**	1.730	(0.763)

Note: (1) The question is “Please select the item that most accurately describes your overall current health. (Circle only one)”.

(B) 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: (1) The difficulty in performing daily activities asked in the JSTAR survey is as follows: *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*, and *Pick up a small object such as a one-yen coin from a desktop with your fingers*.

(C) 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: (1) The chronic diseases asked in the JSTAR survey is as follows: *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)*, and *Other*.

Table 3 Descriptive Statistics

Sample	Full sample				Subsample			
Endogenous variables	Mean	SD	Min	Max	Mean	SD	Min	Max
Care Receiver's Care Level (H_R)	1.408	1.878	0	5	1.812	1.952	0	5
Caregiver's Self-reported Subjective Health Status (H_{G1})	1.712	0.713	0	4	1.716	0.720	0	4
Caregiver's Difficulty in Performing Daily Activities (H_{G2})	0.122	0.327	0	1	0.131	0.338	0	1
Caregiver's Chronic Diseases Diagnosed by a Doctor (H_{G3})	0.441	0.497	0	1	0.448	0.497	0	1
Care Receiver's Characteristics								
Gender (=1 if 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
Nursing Facility Admission (=1 if Yes)	0.208	0.406	0	1	0.268	0.443	0	1
Caregiver's Characteristics								
Gender (=1 if 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 Status (=1 if married)	0.903	0.296	0	1	0.881	0.323	0	1
Number of Dependent Minors (Aged 19 and Under)	0.091	0.388	0	4	0.079	0.368	0	4
Gross Yearly (Marital) Income (10 million yen)	0.400	0.661	0	27.524	0.387	0.699	0	27.524
Amount of (Marital) Assets (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

Table 4 Empirical Results of the Care Receiver's and Caregiver's Health Production Equations Using the Full Sample

Model	Ordered Probit			Bivariate Ordered Probit			Bivariate Ordered Probit		
Caregiver's Health Status	H_{G1}	H_{G2}	H_{G3}	H_{G1}	H_{G2}	H_{G3}	H_{G1}	H_{G2}	H_{G3}
Care receiver's Health Production Equation									
Caregiver's Health Status	0.066**	-0.007	-0.019	0.436	0.196**	-0.053	0.687	0.238***	0.024
	(0.026)	(0.055)	(0.039)	(0.363)	(0.078)	(0.191)	(0.502)	(0.090)	(0.322)
Gender (Female)	0.091*	0.090*	0.090*	0.089**	0.059	0.092*	0.078	0.052	0.089*
	(0.047)	(0.048)	(0.047)	(0.045)	(0.049)	(0.048)	(0.052)	(0.049)	(0.050)
Age	0.052	0.049	0.049	0.055	0.070	0.046	0.051	0.074	0.051
	(0.067)	(0.067)	(0.067)	(0.067)	(0.067)	(0.069)	(0.067)	(0.067)	(0.070)
Squared Age	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nursing Facility Admission	0.432***	0.436***	0.436***	0.359***	0.420***	0.438***	0.265	0.414***	0.434***
	(0.041)	(0.041)	(0.041)	(0.112)	(0.043)	(0.042)	(0.247)	(0.045)	(0.047)
Caregiver's Health Production Equation									
Gender (Female)				-0.027	0.007	-0.032	-0.026	0.010	-0.034
				(0.036)	(0.054)	(0.038)	(0.036)	(0.054)	(0.038)
Age				0.040	-0.030	0.015	0.027	-0.033	0.017
				(0.061)	(0.086)	(0.070)	(0.067)	(0.086)	(0.070)
Squared Age				-0.000	0.000	-0.000	-0.000	0.000	-0.000
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nursing Facility Admission				0.083*	-0.005	0.045	0.090*	0.005	0.048

	(0.046)	(0.066)	(0.054)	(0.048)	(0.066)	(0.054)
Instrumental variables (Caregiver's attributes)						
Gender (Female)	0.047	0.350***	-0.071	0.057	0.328***	-0.064
	(0.078)	(0.081)	(0.083)	(0.046)	(0.078)	(0.093)
Age	-0.179**	-0.148	-0.078	-0.141	-0.153	-0.085
	(0.087)	(0.105)	(0.091)	(0.141)	(0.102)	(0.094)
Squared Age	0.001**	0.002*	0.001	0.001	0.002**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Years of Education	-0.021	-0.029**	-0.017	-0.015	-0.029*	-0.017
	(0.016)	(0.017)	(0.013)	(0.022)	(0.017)	(0.014)
Marriage Status	-0.171**	-0.190**	-0.037	-0.137	-0.183**	-0.045
	(0.073)	(0.095)	(0.107)	(0.122)	(0.093)	(0.111)
Number of Dependent Minors	-0.025	-0.076	0.110	-0.012	-0.072	0.112
	(0.067)	(0.105)	(0.089)	(0.059)	(0.101)	(0.090)
Gross Yearly (Marital) Income	-0.042	-0.083	0.102**	-0.033	-0.084	0.099**
	(0.031)	(0.075)	(0.048)	(0.039)	(0.071)	(0.050)
Amount of (Marital) Assets	-0.012	-0.021	-0.007	-0.004	-0.017	-0.005
	(0.024)	(0.027)	(0.022)	(0.024)	(0.027)	(0.024)
Financial Support	-0.098	0.089	0.132	-0.076	0.084	0.129
	(0.082)	(0.102)	(0.099)	(0.095)	(0.100)	(0.102)
Hours of Providing Informal Care per Day				0.022	0.036	0.016
				(0.020)	(0.022)	(0.037)
arctanh (ρ)	-0.414	-0.226**	0.045	-0.780	-0.275**	-0.035

				(0.439)	(0.090)	(0.196)	(0.911)	(0.104)	(0.331)
ρ				-0.392	-0.222	0.045	-0.653	-0.268	-0.035
				(0.372)	(0.085)	(0.196)	(0.523)	(0.097)	(0.331)
Number of observations	4535	4535	4535	4535	4535	4535	4535	4535	4535
Number of groups (individuals)	2700	2700	2700	2700	2700	2700	2700	2700	2700
Number of clusters (families)	1582	1582	1582	1582	1582	1582	1582	1582	1582
Log Likelihood	-5351.62	-5355.04	-5354.94	-10026.67	-6915.34	-8078.45	-10025.15	-6912.90	-8078.06
F/ Wald statistics: all coefficients. = 0	878.73***	872.80***	872.69***	44.37***	118.42***	352.71***	39.90**	119.24***	355.43***
F/ Wald test: year fixed effects = 0	388.61***	383.34***	298.44***	93.52***	345.24***	309.73***	13.37***	318.56***	310.68***
F/ Wald test: municipal fixed effects = 0	92.43***	91.38***	81.20***	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

Note: (1) ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels.

(2) Standard errors in parentheses are the clustering robust standard errors that allow for correlated residuals within families.

(3) All equations contain year and municipal fixed effects.

Table 5 The Effect of Informal Caregivers' Health on Their Elderly Parents' Health

Model	Ordered Probit			Bivariate Ordered Probit			Bivariate Ordered Probit		
Caregiver's Health Status	H_{G1}	H_{G2}	H_{G3}	H_{G1}	H_{G2}	H_{G3}	H_{G1}	H_{G2}	H_{G3}
	0.066**	-0.024	-0.036	-0.186	0.162*	-0.237	-0.287	0.199***	-0.205
	(0.028)	(0.059)	(0.043)	(0.546)	(0.086)	(0.232)	(1.346)	(0.089)	(0.373)
Number of observations	3524	3524	3524	3524	3524	3524	3524	3524	3524
Number of groups (individuals)	2075	2075	2075	2075	2075	2075	2075	2075	2075
Number of clusters (families)	1578	1578	1578	1578	1578	1578	1578	1578	1578
Log Likelihood	-4847.29	-4850.23	-4849.94	-8515.39	-6123.85	-6958.24	-8515.32	-6120.71	-6958.19
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

Note: (1) See Table 5.

(2) All equations control the attributes of care receiver and caregiver and year and municipal fixed effects.

Table 6 The Effect of Informal Caregivers' Health on Their Elderly Parents' Health Excluding Genetic Effect between Parents and Children

(A) Full sample

Model	Ordered Probit			Bivariate Ordered Probit			Bivariate Ordered Probit		
Caregiver's Health Status	H_{G1}	H_{G2}	H_{G3}	H_{G1}	H_{G2}	H_{G3}	H_{G1}	H_{G2}	H_{G3}
	0.079*	0.156	0.057	0.671***	0.263	-0.078	0.696***	0.276	-0.060
	(0.043)	(0.098)	(0.065)	(0.252)	(0.298)	(0.390)	(0.255)	(0.331)	(0.446)
Number of observations	1738	1738	1738	1738	1738	1738	1738	1738	1738
Number of groups (individuals)	1197	1197	1197	1197	1197	1197	1197	1197	1197
Number of clusters (families)	972	972	972	972	972	972	972	972	972
Log Likelihood	-1874.58	-1875.01	-1875.97	-3656.52	-2422.35	-2940.55	-3656.31	-2422.31	-2940.52
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

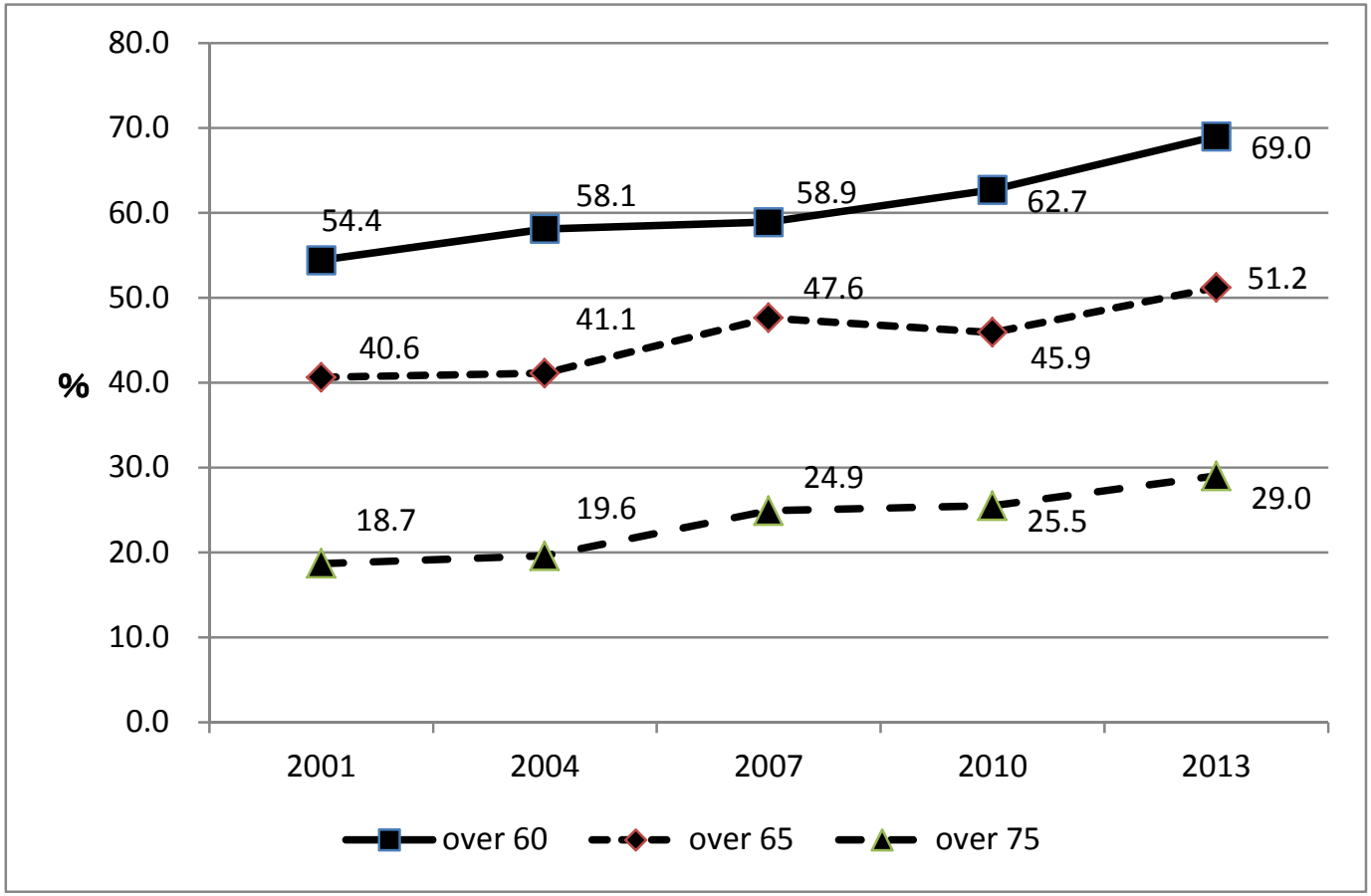
(B) Subsample

Model	Ordered Probit			Bivariate Ordered Probit			Bivariate Ordered Probit		
Caregiver's Health Status	H_{G1}	H_{G2}	H_{G3}	H_{G1}	H_{G2}	H_{G3}	H_{G1}	H_{G2}	H_{G3}
	0.082*	0.119	0.098	0.904***	0.592*	-0.632**	0.902***	0.598*	-0.636**
	(0.046)	(0.109)	(0.073)	(0.124)	(0.321)	(0.301)	(0.123)	(0.314)	(0.310)
Number of observations	1215	1215	1215	1215	1215	1215	1215	1215	1215
Number of groups (individuals)	840	840	840	840	840	840	840	840	840
Number of clusters (families)	765	765	765	765	765	765	765	765	765
Log Likelihood	-1621.31	-1622.20	-1621.95	-2860.58	-2038.26	-2349.39	-2860.21	-2037.99	-2349.38
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

Note: (1) See Table 5.

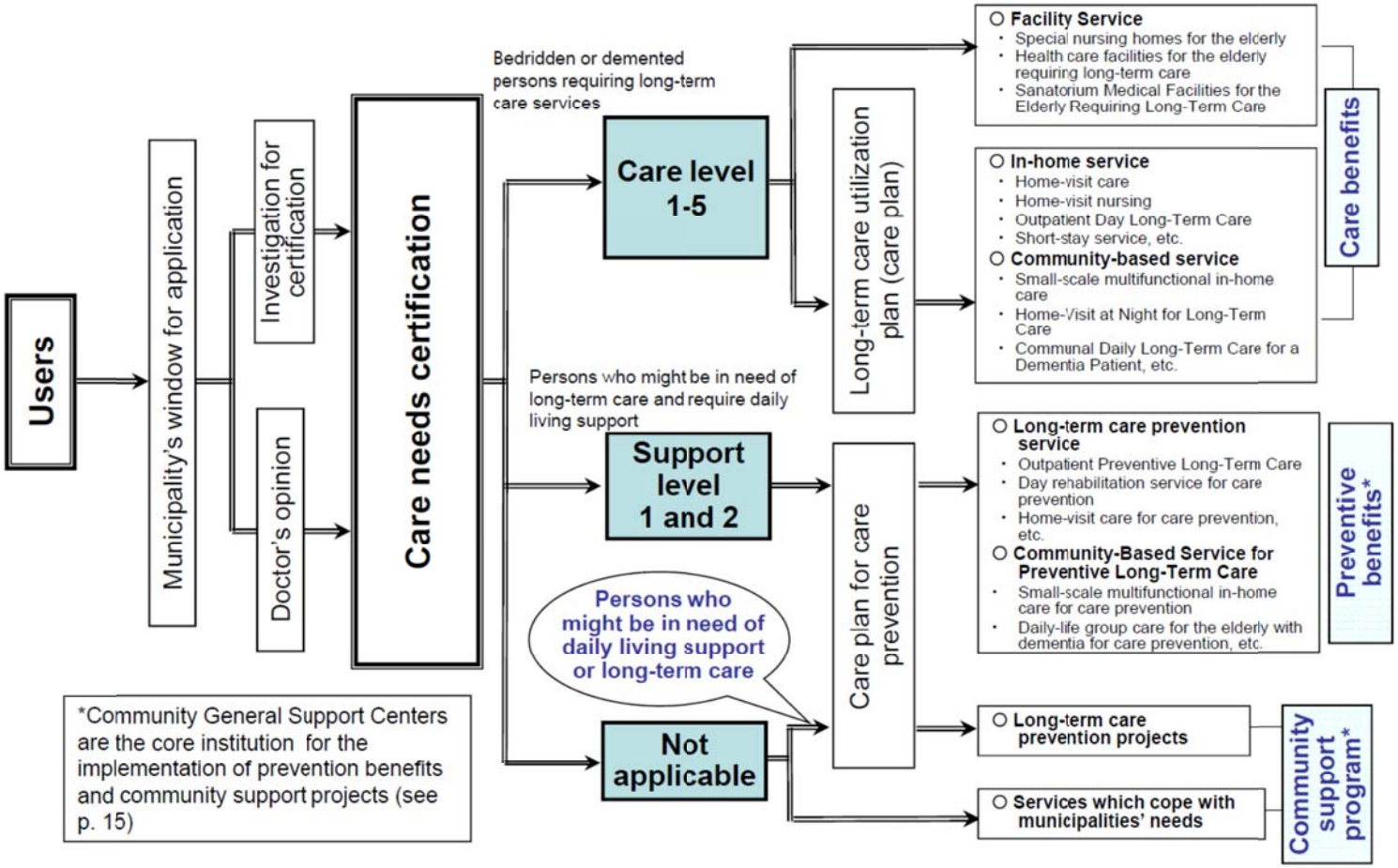
(2) All equations control the attributes of care receiver and caregiver and year and municipal fixed effects.

Figure 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..

Figure 2 An Overview of the Decision Process for the Elderly's Care Level and Plan for Their Long-term Care Services in Japan



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