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Research Article

Projection of Social Burden of the Elderly in Japan Using INAHSIM-II

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By using a microsimulation model named INAHSIM, we conducted a household projection in Japan for the period of 2011–2060. Due to rapid aging of the population, the distribution of the elderly (65 years old or older) by living arrangement and dependency level has a profound impact on the future social burden. In this paper, we measured the social burden of the elderly by three variables: (1) institutionalization rate (percentage of the elderly living in institutions), (2) parent-child ratio (relative number of old parents taking into account the number of brothers and sisters), and (3) one-year transition matrix of the elderly by household type. Especially, the choice of the elderly among (a) living independently, (b) coresident with child households, and (c) moving to institutions are crucial indicators for the future social burden of the elderly in Japan.

1. Introduction

The household is one of the most important statistical bases for policy formulation on health and welfare. The average number of household members is declining, and the number of single households is increasing in Japan. However, the household is still an important unit for various policies, and elderly in one-person household tend to require support of various kinds in aging society. Although expanding recently, statistical information on households and families is still inadequate, to understand the dynamic process of formation and dissolution of households and families in a systematic and coordinated way.

Dynamic microsimulation models are considered to be the most suitable method to observe the dynamic evolution of households and families and to forecast their future trends. While most microsimulation models developed to date have focused on the household sector, a number have been created which simulate the behavior of businesses, rather than individuals or households [1]. However, the dynamic microsimulation method does have some drawback, including difficulties in obtaining the initial population as well as estimating the transition probabilities. INAHSIM-II is a solution to avoid the difficulty to obtain initial population for the model.

INAHSIM (Integrated Analytical Model for Household Simulation) is a dynamic microsimulation model, which was first developed in 1984-85 in Japan by using an actual initial population derived from a national household survey. The main purpose of INAHSIM was to prepare projections to get information on the future number and composition of households, and to analyze households and families in terms of the dynamic transition of household types, family systems, and so forth. Since the 1994 Simulation, the initial population for the model was formed by using the INAHSIM model itself. This is especially important in Japan where it is particularly difficult to use microdata of household surveys to obtain the initial population. The 2004 Simulation improved the process of creating the Initial Population and added the dependency of the elderly in the model. In the 2009 Simulation, the creation process of the Initial Population was further improved and the dependency of the elderly was directly related to the data of the Long-term Care Insurance (LCI) implemented since April 2000, and institution was incorporated in the model for the first time as an option to move.

In the INAHSIM 2011 Simulation, setting 2010 as the start year, we conducted a household projection in Japan for the period of 2011–2060. INAHSIM-II specifically means that the initial population is created by using the INAHSIM model itself. Same as the 2009 Simulation, the dependency level of the elderly aged 65 or over was based on the data from the Long-term Care Insurance, and institution was among options of living arrangement for the elderly.

In this paper, basic features of the INAHSIM 2011 Simulation and some standard results from the simulation are shown in Section 2. Simulation results for the elderly are described in details in Section 3. In Section 4, we discuss the social burden of the elderly using the simulation results in Section 3. Japan is already the most aged country among major developed countries, and its aging rate (the proportion of those who are 65 years old or over to the total population) is expected to reach 40 percent in 2060. We assume those discussions on social burden of the elderly will be relevant to all developed countries.

2. INAHSIM 2011 Simulation

Observing the basic framework of the 2004 Simulation and the 2009 Simulation, the 2011 Simulation had the following characteristics: (a) the Initial Population was formed by using the INAHSIM model itself; (b) the dependency of the elderly was related to the data of the Long-term Care Insurance (LCI); (c) institutions were included in the model as a possible option for the elderly to move. Whether an elderly person moves to an institution or not depends on living arrangement, marital status, and dependency level. Compared to the 2009 Simulation [2], the 2011 Simulation had the following features:

(i) Base year was set as 2010, and all transition probabilities are renewed for this new base year.

(ii) More attention was paid to the living arrangement of the elderly including institution as well as their dependency level in forming simulation cases.

(iii) Discussions on parent-child ratio and living arrangement of the elderly are possible by comparing simulation results among different simulation cases.

2.1. Initial Population. Preparation of the Initial Population was done by two steps. First, individual males and females, 6,000 of each, aged 20–29 according to age distribution in 2010, was created and put into the model. A simulation was executed for 210 years in order to obtain a stable population, using a set of transition probabilities prepared for this process. Next in Step 2, the baby-boomer generations were created using a specific set of transition probabilities. The final state of this Step 2 is compared to the actual data in 2010 in Table 1. Simulation methods are briefly described in Appendix A.

Through these two steps, the Initial Population consisted of 227,241 individuals in 94,195 households. The Initial Population obtained was fairly good in general as shown in Table 1. However, there was still a certain discrepancy in the living situation of the elderly between the Initial Population and the result from the Population Census and the Basic Household Survey. Throughout the simulation, the Initial Population was fixed.

2.2. Transition Probabilities. Various transition probabilities shown in Appendix B are used in the model. The death rate is given by age (single year of age) and sex for those who are less than 65 years old, but it is determined by dependency transition which is given by age (5 year age group) and sex for those who are 65 years old or over. The dependency of the elderly aged 65 or over is classified into 4 levels as follows:

Level 0: No disability and completely independent.

Level 1: Some disability but basically independent.

Level 2: Slightly or moderately dependent.

Level 3: Heavily dependent.

Levels 2 and 3 correspond to persons eligible for the LCI, and Level 3 corresponds to care need assessments 4 and 5 of the LCI in particular.

We employed four kinds of household merger. (a) Coresidency rate of adult child with parents upon marriage. (b) Reuniting rate of adult child to the parent's household upon becoming widowed. (c) Reuniting rate of adult child to the parent's household upon divorce. (d) Merger rate of aged parent(s) with the child generation. The merger rate of aged parent(s) changes according to marital status, average age, and dependency of aged parent(s).

Concerning the possibility of the elderly to move into institutions, we assumed two cases: Standard case (S) and Independent case (I). In Standard case, elderly in one-person household with dependency level 2 moves to an institution if and only if he or she cannot merge into a child's household, and elderly in one-person household with dependency level 3 always moves to an institution. Concerning elderly couples in couple-only household, assumed movement depends on the couple's dependency level and the availability of a child's household as shown below (number indicates dependency level).

Standard Case (S):

Elderly in one-person household (2): Merge to child generation, otherwise move to institution

Elderly in one-person household (3): Always move to institution

Elderly couple 1 and 2: merge to child generation, otherwise (2) moves to institution

Elderly couple 0 and 3; 1 and 3: (3) always moves to institution

Elderly couple 2 and 2; 2 and 3; 3 and 3: Both always move to institution.

In Independent case, elderly in one-person household with dependency level 2 moves to an institution with a probability of 0.2 per year if he or she cannot merge into a child's household. Concerning elderly couples in couple-only household, assumed probability of the elderly to move to institution was smaller than Standard case as described below (number indicates dependency level).

Table 1: Creation of initial population for 2010.

	Step 1	Step 2	Actual
	Population and household (in %)		
Population by age group			
0–14	30.4	13.1	13.1
15–64	58.8	63.2	63.8
65+	10.8	23.7	23.0
Household structure			
One-person (IP)	14.1	34.0	32.4
Couple only (Co)	12.1	18.6	19.8
Couple and child(ren) (CC)	52.7	26.2	27.9
Single parent and child(ren) (SC)	3.2	5.7	8.7
Three generation (3G)	11.3	7.7	7.1
The others (Oth)	6.6	7.7	4.1
Living situation of 65+			
One-person	10.3	16.9	16.9
Couple only	38.8	34.3	37.2
Coresident with child (couple)	33.8	20.8	17.5
Coresident with child (without spouse)	8.4	17.8	24.8
The others	6.3	7.4	3.7
Institution	2.3	2.8	—

Note: Actual figures are from the Population Census (Population and Household structure) and the Basic Households Survey (Living situation of 65+).

Independent Case (I):

Elderly in one-person household (2): Merge to child generation, otherwise move to institution with a probability of 0.2 per year.

Elderly in one-person household (3): Always move to institution.

Elderly couple 1 and 2: merge to child generation, otherwise (2) moves to institution with a probability of 0.2 per year.

Elderly couple 0 and 3: (3) moves to institution with a probability of 0.2 per year.

Elderly couple 1 and 3; 2 and 3: (3) always moves to institution.

Elderly couple 2 and 2: Both move to institution with a probability of 0.2 per year.

Elderly couple 3 and 3: Both always move to institution.

2.3. Simulation Cases. The total fertility rate was assumed to remain the same throughout the simulation period, and we assumed three levels (TFR = 1.4, 1.3, and 1.6). On the other hand, the death rate was assumed to decline gradually, and life expectancy at birth would be 84 years for males and 90 years for females in 2060. Concerning the possibility of the elderly to move to institution, we assumed two cases, Standard case (S) and Independent case (I), as mentioned above. Therefore, we conducted 6 simulation cases: S (1.4), S (1.3), S (1.6), I (1.4), I (1.3), and I (1.6).

2.4. Basic Results. According to the 2011 simulations, the total population continues to decline throughout the projection periods, while aging of the population will continue until 2050 (Figure 1). Total population and aging rate in future years are inline with the result of the latest official population projection published by the IPSS [3].

Table 2 shows basic results of the simulation for Standard case & TFR = 1.4. The total number of population will decrease from 128 million in 2010 to 85 million in 2060, and aging rate will be 38 percent in 2060. The total number of household starts decreasing since 2010, but the number of households with elderly members (65+) will reach 24 million in 2040 and starts decreasing thereafter (Table 2).

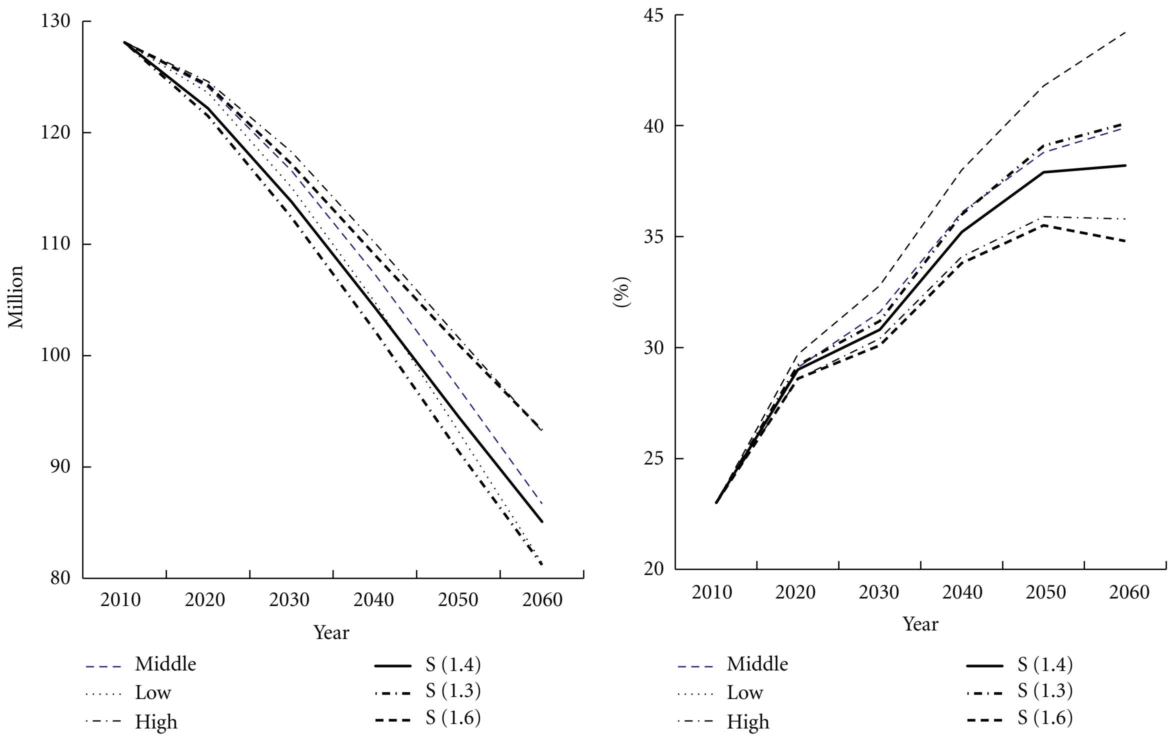
3. 2011 Simulation Results for the Elderly

3.1. Living Arrangement of the Elderly. Table 3 shows the living situation of the elderly (65+) for Standard case and TFR = 1.4. Past data from the Basic Household Survey are also included in the table, although this survey excludes those people who stay in institutions. In 2010, among the elderly population, 16.9 percent live in one-person households, 37.2 percent in couple-only households, and 42.3 percent live with the child generation. According to the simulation, the proportion of one-person households will increase and the proportions of both couple-only households and coresident with child couple will decrease. The proportion of those elderly who stay in institutions will steadily increase throughout the projection periods. The rate will be about 10 percent in 2060 for Standard case (Table 3), but it will remain 6.6 percent in 2060 for Independent case.

Table 2: Future population and households.

Year	Total	Elderly (65+)	Population (in million, %) Age structure (%) 0–14	15–64	65+	(Re)75+	Number of Households (in million) Total	With 65+
2000	126.9	22.0	14.6	68.1	17.4	7.1	46.8	15.0
2010	128.1	29.2	13.1	63.8	23.0	11.0	51.8	19.3
2020	122.2	35.5	12.2	58.8	29.0	14.5	50.0	23.4
2030	113.8	35.0	10.8	58.4	30.8	18.7	47.3	23.4
2040	104.3	36.8	10.8	54.0	35.2	19.4	44.1	24.0
2050	94.5	35.8	10.5	51.6	37.9	23.4	40.3	23.4
2060	85.1	32.5	9.8	51.9	38.2	26.0	35.9	20.9

Note: Figures for 2000 and 2010 are based on the Population Census.



(a) Total population

(b) Aging rate

Figure 1: Total population and aging rate. Middle, low, high mean middle, low, and high scenarios of the population projection by the IPSS as of January 2012, respectively.

The living situation of the elderly is rather different between males and females. Reflecting the difference in death rates, the proportion of one-person households is higher for females than males, and this discrepancy increases with age (from 10.4 percent for 65–69 to 12.1 percent for 80+ for males and from 14.9 percent for 65–69 to 26.6 percent for 80+ for females in 2010). However, the increase in the proportion of one-person households among male elderly is remarkable, and it will reach female level in 2050 (Table 3).

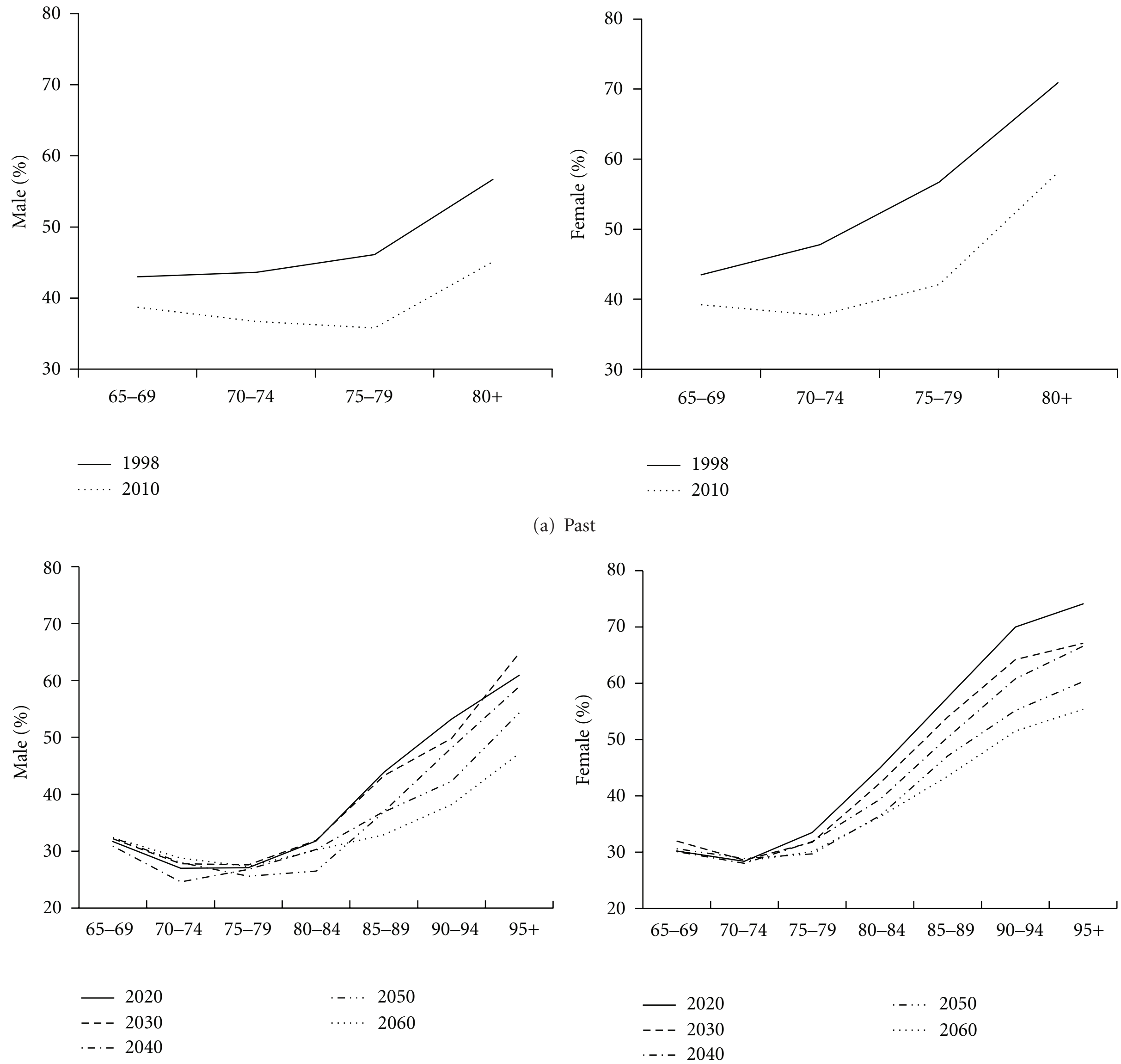
The coresidency rate of the elderly aged 65 or over declined from 70 percent in 1980 to 50 percent in 2000, and it was 42 percent in 2010. Figure 2 shows past and future coresidency rate of the elderly according to age group and sex. The coresidency rate of the elderly increases with age, and the historical trend of declining coresidency rate maintains in future years. The number of female elderly staying in institutions is higher than that of male elderly. However the proportion of those who stay in institutions is rather similar between males and females.

Table 4 shows the distribution of the elderly by dependency level. The proportion of dependency level 2 was 8.7 percent (6.0 percent for males and 10.7 percent for females) and dependency level 3 was 3.5 percent (2.2 percent for males and 4.5 percent for females) in 2010. As shown in Table 4, the proportions of those elderly with dependency levels 2 and 3 will steadily increase especially among females.

Table 3: Living situation of the elderly (65+).

Year	Total (in %)						Institution	Male (in %)						Female (in %)					
	1P	Co	Coresident with child					1P	Co	Coresident with child				1P	Co	Coresident with child			
			a	b	c	d				a	b	c	d			a	b	c	d
2007	15.7	36.7	9.6	10.0	16.9	7.2		9.7	46.1	11.5	3.5	22.7	2.7	20.4	29.3	8.1	15.1	12.3	10.7
2010	16.9	37.2	8.4	9.1	17.4	7.4		10.9	46.4	10.0	3.1	23.0	2.8	21.5	30.0	7.1	13.8	13.1	10.9
2020	20.8	32.7	5.6	10.9	12.2	6.9	3.6	18.6	38.6	6.6	5.3	15.5	3.9	22.6	28.1	4.9	15.2	9.7	9.2
2030	22.6	28. 8	5.3	11.1	12.3	7.9	5.2	20.6	34.5	6.3	6.0	15.6	4.7	24.1	24.5	4.6	15.1	9.8	10.4
2040	24.4	26.0	4.7	9.9	12.6	8.1	6.1	23.5	30.9	5.5	5.1	15.8	4.5	25.1	22.2	4.1	13.7	10.2	11.0
2050	26.6	24.4	4.6	8.8	12.7	8.0	7.4	26.4	28.2	5.2	4.7	16.1	4.4	26.7	21.3	4.0	12.1	10.0	10.8
2060	25.9	21.4	4.7	9.3	12.3	8.5	9.9	26.4	24.6	5.5	5.2	16.0	4.7	25.5	18.9	4.1	12.5	9.4	11.5

(Note 1) IP: One-person. Co: Couple only.
a,b: Coresident with child (Couple) of elderly couple (a) or elderly without spouse (b).
c,d: Coresident with child (Without spouse) of elderly couple (c) or elderly without spouse (d).
(Note 2) Figures for 2007 ard 2010 are from the Basic Households Survey, which excludes those who stay in institutions.



(a) Past

(b) Future (Standard case & TFR = 1.4)

Figure 2: Coresidency rate of the elderly according to age group and sex.

Table 4: Distribution of the elderly (65+) by dependency level.

Year	Total (in %) Dependency level				Male (in %) Dependency level				Female (in %) Dependency level			
	0	1	2	3	0	1	2	3	0	1	2	3
2010	87.8		8.7	3.5	91.8		6.0	2.2	84.8		10.7	4.5
2020	72.6	14.1	9.2	4.1	70.6	18.6	8.0	2.8	74.2	10.7	10.1	5.0
2030	68.7	15.0	10.9	5.4	66.1	20.3	9.6	3.9	70.6	10.9	11.9	6.6
2040	68.2	14.3	11.2	6.3	66.4	19.2	9.9	4.5	69.5	10.5	12.2	7.8
2050	66.1	15.6	11.5	6.8	63.6	21.2	10.4	4.8	68.0	11.1	12.4	8.4
2060	60.8	16.4	13.8	9.0	58.5	22.8	12.4	6.3	62.6	11.3	14.9	11.1

Note: Dependency level.
0: No disability and completely independent.
1: With some disability but independent.
2: Slightly or moderately dependent.
3: Heavily dependent.

Table 5: One- year transition matrix of the elderly by household type: 2019-2020, Standard case and TFR = 1.4.

Household type	Number in 2019 (in thousand)	Number in 2020 (in thousand) IP	Co	a	b	c	d	Oth	Ins	Died (in thousand)
Total	35,130	7,388	11,595	1,993	3,863	4,331	2,434	2,591	1,273	1,446
One-person (IP)	7,304	6,563	7	24	239	4	120	9	176	161
Couple-only (Co)	11,540	279	10,693	65	33	61	15	21	94	280
Coresident										
a	1,986	0	0	1,790	89	13	1	10	0	84
b	3,843	0	0	0	3,463	0	33	25	0	321
c	4,255	8	179	34	1	3,809	86	39	0	99
d	2,387	68	1	0	20	1	2,110	21	0	166
Others	2,584	66	153	4	5	2	2	2,246	0	105
Institution	1,233	0	0	0	0	0	0	0	1,003	229
Newly became 65		404	561	77	14	441	68	219	0	—

Total number of the eldery: from 35,130 thousand in 2019 to 35,469 thousand in 2020.

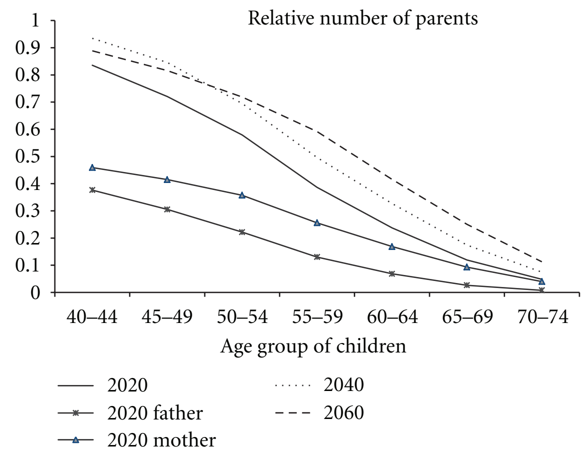


Figure 3: Relative number of parents according to age group of children: Standard case and TFR = 1.4.

3.2. *Relative Weight of the Elderly.*

Relative number of parents weighted by the number of brothers and sisters of children is obtained from the calculation as follows [4]:

$R(y)$ = Relative number of parents according to age group of children (y), n = number of brothers and sisters of children, $F_n(y) = \sum_n F(y,n)$, where $F(y,n)$ = Number of children of age group y with n brothers and/or sisters, $G(y) = \sum_n G(y,n)/n$, where $G(y,n)$ = Number of parents with children of age group y and n brothers and/or sisters; $R(y) = G(y)/F(y)$.

Figure 3 shows the results for the years 2020, 2040, and 2060. As low fertility is assumed to continue and life expectancy will be prolonged, the relative number of parents to adult children aged 40 or over will increase remarkably in the future. The relative number of mothers is higher than that of fathers reflecting the difference in death rate by sex. For age group 60–64, for example, the relative number of parents will steadily increase from 0.24 in 2020 to 0.42 in 2060 for Standard case and TFR = 1.4. The difference in fertility rates (TFR 1.3 and 1.6) has little effects on this index.

3.3. *Dynamic Transition of the Elderly by Household Type.*

Table 5 shows a one-year transition matrix of the elderly by household type from 2019 to 2020 for Standard case and TFR = 1.4. From 2019 to 2020, 1.8 million persons are estimated to become 65 years old and 1.4 million elderly

Table 6: Yearly transition rate by household type for the elderly (65+) Standard case and TFR = 1.4.

Household type	Year (in %)				
	2020	2030	2040	2050	2060
Total	10.3	10.3	10.4	9.4	9.4
One-person (IP)	10.7	10.2	9.7	8.5	8.7
Couple-only (Co)	7.6	7.9	8.4	7.4	8.0
Coresident					
a	10.0	10.3	9.8	8.9	7.8
b	10.1	9.5	9.2	9.0	8.2
c	11.3	10.9	11.9	9.8	9.4
d	12.5	11.7	11.2	10.2	9.7
Others	13.2	14.1	13.3	11.9	12.2
Institution	19.9	17.8	16.3	15.6	13.8

Table 7: Summary comparative table for 2030.

	Standard case TFR			Independent case TFR		
	1.3	1.4	1.6	1.3	1.4	1.6
Living arrangement of the eldserly (65+)						
Coresidency rate (%)	36.2	36.7	37.1	37.4	37.6	37.6
Institutionalization rate (%)	5.1	5.2	5.0	3.1	3.1	3.1
Parent-child ratio at age-group 60–64	0.299	0.294	0.300	0.299	0.299	0.309
Yearly transition rate for 65+ (%)						
Coresident a	9.8	10.3	11.3	10.5	10.9	11.3
Coresident b	9.1	9.5	9.6	9.9	9.1	9.6
Institution	17.2	17.8	18.1	17.6	17.3	18.1

Table 8: Derivation of model parameters (transition probabilities).

Event	Transition Probabilities		Value
Birth	Birth rate	Age of mother and birth order	
	Sex ratio at birth		105.5 males for 100 females
Death	Death rate	Age and sex for 0–64 years old	
	Dependency transition	Age and sex for 65+ years old	
Marriage	First marriage rate	Age and sex	
	Remarriage rate	Age and sex	
Divorce	Divorce rate	Duration of marriage	
	Probability of husband leaving household upon divorce		0.6939
Separation and return	Separation rate	Age, sex, and marital status	
	Return rate	Age, sex, and marital status	
Household merger	Coresidency rate of adult child with parents upon marriage		Bridegroom's 0.40901 Bride's 0.17647 (no brothers) Bride's 0.02373 (otherwise)
	Reuniting rate of adult child to the parent's household upon becoming widowed		0.3
	Reuniting rate of adult child to the parent's household upon divorce		Male 0.43 Female 0.35
	Merger rate of aged parent(s) with child generation	Marital status, average age of aged parent(s), and dependency Standard rate U is modified according to dependency as follows: Dependency: 0 / 1 / 2 / 3 Single: ×0.8 / ×1.0 / ×1.5 / 1.0 Couple: ×0.5 / ×0.5 / ×0.7 / ×1.0	Standard merger rate of aged parent(s), U, changes according to age and marital status: single male 0.015 (65) to 0.207 (100), single female 0.015 (65) to 0.123 (100), and couple 0 (65) to 0.05 (100).

will die, and 31.7 million elderly will remain in the same household type. Among 1,233 thousand elderly staying in institutions in 2019, 1,003 thousand remain in institutions and 229 thousand die. From one-person households, 176 thousand move to institutions, and 94 thousand elderly move to institutions from couple-only households in 2020. About 90 percent of the elderly as a whole will remain in the same household type.

The stability of each household type is measured by the yearly transition rate, which is calculated by 1 − (Number of the elderly remaining in this household type)/(Average number of the elderly in this household type). Taking an example of Standard case and TFR = 1.4, the average number of the elderly in one-person households during 2019-2020 will be 7,346 thousand, and the yearly transition rate of one-person households is 10.7 percent (Table 6). The yearly transition rate of institution for Standard case & TFR = 1.4 will decrease from 20 percent in 2020 to 14 percent in 2060. For Independent case, it will decrease from 18 percent to 14 percent during the same period, and there is only a small difference between the two cases.

4. Discussion

In this paper, we measured the social burden of the elderly by three variables: (1) institutionalization rate (percentage of the elderly living in institutions), (2) parent-child ratio (relative number of old parents taking into account the number of children), and (3) one-year transition matrix of the elderly by household type. Table 7 summarizes main results of three variables by simulation cases in 2030. From this table, the followings can be stated:

(i) coresidency rate of the elderly will be slightly higher in Independent case than Standard case;

(ii) institutionalization rate of the elderly will be lower in Independent case, although there will be little difference in yearly transition rate of institution for 65+ between Standard case and Independent case;

(iii) the relative number of parents to adult children aged 60–64 will be around 0.30, and this variable will be stable among simulation cases.

Transition probabilities used are important in evaluating the results of the simulation. As mentioned before, the total fertility rate was assumed to remain constant throughout the simulation period, and we assumed three levels. Concerning death rate, we employed single assumption. The dependency of the elderly aged 65 or over was classified into 4 levels, and we observe a sharp increase in the proportion of heavily dependent elderly between 2010 and 2060. This is because aging of the population will be so severe and the present dependency was assumed for future years. However, future improvement in the dependency of the elderly may well be expected, and it will certainly affect the simulation results.

Institutionalization rate in this paper is rather theoretical, considering only demand side. Moreover, the logic employed here is rather simple, and there is a plenty of room to improve. In reality, rates of institutionalization depend on the availability of places on long term care institutions and their costs as well as on living arrangement, marital status, and dependency level of the elderly. It is difficult to maintain one-person household if his or her dependency level is high, and elderly couple consider moving to institutions if the dependency level of the spouse becomes high. Actual proportion of those elderly who stay in institutions is determined by the availability of places on long term care institutions. Therefore, in improving the institutionalization rate of the elderly, we are confronted with a difficult task of reconciling demand side with supply side.

From the INAHSIM model, we can obtain a population-household projection in a coherent manner as well as dynamic statistics which are difficult to obtain from static surveys or macrosimulation. By changing the starting year of the simulation, INAHSIM is useful for both historical analysis and future projection of households and families [4]. While dynamic models typically do capture some types of behavioral change, they face problems (like static models) when attempting to incorporate either behavioral change in response to government policy changes or second round effects because they do not necessarily allow changes in behavior initiated by government policy changes [1].

If we construct a pertinent initial population and improve the accuracy of transition probabilities, then we can extract useful information from the INAHSIM, which is only available from dynamic microsimulation model. Transition probabilities are able to be changed annually. In order to analyze the family lifecycle, it is necessary to improve the accuracy of various transition probabilities on household mergers. By adding place of dwelling, housing, and employment situation into the model, we can improve the usefulness of the model remarkably. Inagaki [5] added employment situation into the model, and analyzed the effects of recent increases in nonregular workers on the future fertility and household situation. Fukawa [2] applied the simulation results to make a projection of health and long-term care expenditures in Japan.

Due to rapid aging of the population, the distribution of the elderly by living arrangement and dependency level has a profound impact on the future social burden. A parent-child ratio taking into account the dependency as well as the choice of the elderly among (a) living independently, (b) coresident with child households, and (c) moving to institutions have a profound impact on future LCI expenditures in Japan. These results may change according to assumptions, but projections are useful in considering ways how to reorganize the social security system under the circumstances of aging of the population and low fertility in Japan. In considering a suitable scale of social security benefits, projection results are indispensable to persuade the general public to accept a higher burden or lower benefit.

5. Conclusions

By using a dynamic microsimulation model named INAHSIM, we conducted a household projection in Japan for the period of 2011–2060. We measured the social burden of the elderly by three variables: (1) institutionalization rate (percentage of the elderly living in institutions), (2) parent-child ratio (relative number of old parents taking into account the number of children), and (3) one-year transition matrix of the elderly by household type. Simulation results are useful in considering ways how to reorganize the social security system under the circumstances of aging of the population and low fertility in Japan.

Appendices

A. Simulation Methods

INAHSIM is a dynamic microsimulation model, and the occurrence of each event is based on the Monte-Carlo method, that is, if and only if a random number generated by the computer for each event is equal to or smaller than the probability given, the event is allowed to occur. When an event is determined to occur, all the necessary procedures will be carried out step by step to simulate the changing of the actual society. The operation of each event is carried out once a year, and the order of operation is as follows: marriage, birth, death, divorce, separation, return, and merger of aged parents. Reuniting of the widowed or divorced with the parent's household is included in the operation of death or divorce, respectively.

In the preparation of Initial Population, higher birth rate, and higher marriage rate were used in order to create the first (born during 1947–1949) and second (born in 1970s) baby-boomer generations. We conducted various modifications in order to obtain an Initial Population which reflects age and household structure of the actual population. However, we did not conduct any modification in the 2011 Simulation.

The Initial Population thus obtained was compared with the result from the Population Census and the Basic Household Survey. The Basic Household Survey is conducted every year by the Ministry of Health, Labour, and Welfare. The survey is done on a large scale once in three years, and the 2010 Survey is among them. The sample size of the 2010 Survey was 289 thousand households with 750 thousand people, and the response rate was 79.6 percent.

B. Derivation of Model Parameters (Transition Probabilities)

See Table 8.

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