Gains and Losses in Life Expectancy with Care Needs from the Elimination of Diseases in Japan

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Research article

Keywords: disability-free life expectancy, life expectancy, care needs, health statistics

Posted Date: December 23rd, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-132858/v1>

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Abstract

Background: Evaluating the impact of diseases on expected years of life with care needs is important in older populations. We examined gains or losses in expected years with care needs at age 65 years in Japan.

Methods: We used Japanese national health statistics data, including care needs, based on long-term care insurance. The number of expected years with and without care needs at age 65 years, after the elimination of five selected diseases in 2010, 2013, and 2016 were calculated using a proposed method.

Results: Expected years without care needs at age 65 years increased from 17.15 years in 2010 to 17.82 years in 2016 for men and from 20.24 to 20.74 years for women; expected years with care needs were between 1.70 and 1.73 years for men and between 3.59 and 3.66 years for women. Elimination of malignant neoplasms and heart diseases led to gains in expected years with and without care needs. Elimination of cerebrovascular diseases, arthropathies, and dementia showed gains in expected years without care needs and losses in expected years with care needs. Gains and losses from elimination of dementia expanded each year but those from elimination of other diseases compressed.

Conclusions: Our results suggest that the prevention of dementia, cerebrovascular diseases, and arthropathies lead to more expected years without care needs and fewer expected years with care needs. The impact of dementia might increase and that of other diseases might decrease each year.

Background

Life expectancy with and without disability or care needs is important for the assessment of health in older populations.¹ Disability-free life expectancy has been investigated in several countries.^{2–5} In Japan, expected years with and without care needs have been calculated using long-term care insurance data, and their trends between 2005 and 2009 have previously been examined.⁶

Reducing the expected number of years with care needs, together with increasing the expected years without care needs, is a primary goal in older populations.^{7,8} In planning how to achieve these goals, evaluating the impact of disease on disability-free life expectancy is essential. As an indicator of disease impact, gains in disability-free life expectancy owing to the elimination of diseases has been reported in several countries, including Japan.^{1,9–11} However the impact of diseases on expected years with and without disability or care needs differ between older and younger populations and change over time.¹

In the present study, gains or losses in expected years with and without care needs, at age 65 years, after the elimination of selected diseases, were calculated using a previously proposed method and using data from long-term care insurance in Japan. We then examined their trends during 2010–2016.

Methods

Long-term care insurance in Japan

The long-term care insurance system in Japan has been described elsewhere.¹² This system, organized by the Ministry of Health, Labour and Welfare, was started on April 1, 2000. Every Japanese person aged 65 years or

more is eligible. The level of care needs is assessed based on each individual's physical and mental status. The care level determines the number of services covered by insurance.

Data

We used population, death, and life-table data of Japan in 2010, 2013, and 2016.^{13,14} The number of individuals with care needs was obtained from the Survey of Long-Term Care Benefit Expenditures at the end of September in 2010, 2013, and 2016, which was based on all claims for long-term care benefit expenditures in Japan.¹⁵

The proportion of primary causative diseases leading to care needs among persons with care needs living at home was obtained from a long-term care questionnaire of the Comprehensive Survey of Living Conditions in 2010, 2013, and 2016, which covered about 8,000 individuals with care needs in randomly selected households nationwide.¹⁶ An additional pdf file shows the question about causes of care needs [see Additional file 1]. Data from the surveys were used with permission from the Ministry of Internal Affairs and Communications and the Ministry of Health, Labour and Welfare of Japan.

Because the data we used were national statistical data that was published or used with permission and these statistical data do not include personally identifiable information, no ethical review was needed.

Disease status

We selected five diseases: malignant neoplasms (International Classification of Diseases, Tenth Revision (ICD-10): C00-C97), heart diseases (ICD-10: I01-I02.0, I05-I09, I20-I25, I27, I30-I52), cerebrovascular diseases (ICD-10: I60-I69), dementia (ICD-10: F00-F03 and G30), and arthropathies (ICD-10: M00-M25).¹³

The primary causative disease for individuals with care needs living at home was evaluated using responses to the question, "What is the primary causative disease that has led to your care needs?"¹⁶ The response to the question was one of 12 diseases and injuries, including the five abovementioned diseases, "other disease or injury", and "unknown." A response to any of the five selected diseases was classified as having care needs primarily caused by these diseases.

Calculation of gains or losses in expected years with and without care needs after the elimination of diseases

We calculated the expected years of life with and without care needs at age 65 years in 2010, 2013, and 2016, using the method in a previous study.⁶ The care needs for individuals aged 65 years and older was evaluated using the care need levels certified by the long-term care insurance of Japan.¹² We classified level 2, 3, 4 and 5 as having care needs and the rest as having no care needs. We then calculated the sex- and age-specific prevalence of care needs, according to the following age groups: 65–69, 70–74, 75–79, 80–84, 85–89, 90–94, and 95 years or older.

We calculated the expected years with and without care needs after elimination of each of the above five diseases, using the proposed method.¹⁷ According to a previous study, the method is described as follows.¹⁸ The life table eliminating deaths caused by diseases was constructed using data of the number of deaths and life tables with no disease elimination.¹⁴ The probability of survival at age group x with a disease eliminated (p_x^e)

was given by the probability with no disease elimination (p_x), the number of deaths (D_x) from all diseases and injuries, and the number of deaths from the disease (D_x^e), as follows:

$$\ln(p_x^e) = (1 - D_x^e/D_x) \ln(p_x)$$

where $\ln$ is a natural logarithm function and the age groups are as given above. Using the Chiang life-table method, the number of survivors (I_x^e), the stationary population (L_x^e), and the expected years of life (e_x^e) after eliminating a disease was calculated from the values of p_x^e .¹⁹

We assumed that the proportion of individuals with care needs primarily caused by disease among those with care needs living at home (obtained from the Comprehensive Survey of Living Conditions) was equal to that among all individuals with care needs, including residents in health care and welfare facilities for older people requiring long-term care, by sex, age and care needs level group. Under this assumption, the number of individuals with care needs primarily caused by disease was given to be the proportion among those with care needs living at home multiplied by the number of all individuals with care needs. We calculated the sex- and age-specific prevalence of care needs after eliminating each disease. The numerator of prevalence was individuals with care needs, excluding those with care needs primarily caused by disease. The denominator was all individuals, excluding those with care needs primarily caused by disease.

Using the Sullivan method, we divided the expected years of life in age group x after eliminating disease according to those with and without care needs, as follows:

$$e_x^e = \sum \pi_y^e L_y^e / I_x^e + \sum (1 - \pi_y^e) L_y^e / I_x^e$$

where $\sum$ represents the sum from age group x to the oldest age group in the age group y , and π_y^e is the age-specific prevalence of care needs after eliminating disease.^{1,18,20}

Results

Table 1 shows the prevalence of patients with care needs and death rates in the older population in 2010, 2013, and 2016. The prevalence and death rate increased with age in both men and women in all three years. The sex- and age-specific prevalence and death rates decreased each subsequent year, except in the age group 95 years or more.

Table 1
Prevalence of patients with care needs and death rate in the older population in 2010, 2013, and 2016 in Japan

		Age group, years							Total
		65–69	70–74	75–79	80–84	85–89	90–94	≥ 95	
Men									
Death rate, per 1000 population									
Year:	2010	14.6	22.7	39.6	70.5	120.3	202.5	334.8	41.0
	2013	13.7	21.2	36.8	67.6	116.4	195.3	330.3	40.4
	2016	13.2	21.1	33.5	61.2	111.5	187.7	332.7	39.0
Prevalence of patients with care needs, per 1000 population									
Year:	2010	18.2	35.5	68.1	123.2	213.7	358.2	562.3	68.2
	2013	18.1	34.0	65.6	123.3	213.3	355.5	536.2	69.7
	2016	17.7	33.7	60.5	115.4	207.9	341.8	552.6	68.4
Women									
Death rate, per 1000 population									
Year:	2010	6.0	9.8	17.9	34.3	69.1	131.2	258.1	30.1
	2013	5.7	9.1	16.9	33.8	67.4	131.9	257.8	30.7
	2016	5.4	9.0	15.5	31.1	63.3	126.2	260.3	30.1
Prevalence of patients with care needs, per 1000 population									
Year:	2010	13.3	29.1	67.7	149.4	299.7	498.3	743.9	112.6
	2013	12.8	27.5	65.4	150.1	296.3	503.2	720.1	116.3
	2016	12.5	27.0	59.6	140.6	287.0	488.2	751.7	115.3

Table 2 shows the proportion of patients with care needs and the proportion of deaths owing to the selected diseases in the older population in 2010, 2013, and 2016. The proportion of deaths from malignant neoplasms, heart diseases, and cerebrovascular diseases was relatively high and decreased each year. The proportion of patients with care needs owing to cerebrovascular diseases and the proportion of female patients with care needs owing to arthropathies were relatively high and decreased each year. The proportion of patients with care needs owing to dementia was relatively high and increased with subsequent years.

Table 2
Proportion of patients with care needs and proportion of deaths owing to selected diseases in the older population of Japan (2010, 2013, and 2016)

		Malignant neoplasms	Heart diseases	Cerebrovascular diseases	Dementia	Arthropathies
Men						
Proportion of deaths, %						
Year:	2010	33.1	14.3	9.9	0.6	0.1
	2013	32.6	14.0	8.9	1.0	0.1
	2016	32.5	13.8	7.9	1.2	0.1
Proportion of patients with care needs, %						
Year:	2010	3.6	2.6	35.9	13.8	3.1
	2013	3.6	4.6	32.2	16.1	3.4
	2016	4.2	3.7	29.2	19.0	2.8
Women						
Proportion of deaths, %						
Year:	2010	22.5	19.0	11.7	1.4	0.3
	2013	21.8	18.2	10.4	2.3	0.2
	2016	22.1	17.3	9.1	2.8	0.2
Proportion of patients with care needs, %						
Year:	2010	1.2	1.9	20.8	24.5	8.4
	2013	0.8	2.5	18.8	26.5	6.2
	2016	1.7	3.4	15.6	30.7	5.8

Table 3 shows the baseline and gains in expected years with and without care needs, at age 65 years, after elimination of the selected diseases in 2010, 2013, and 2016. The expected years without care needs at age 65 years increased from 17.15 years in 2010 to 17.82 years in 2016 for men and from 20.24 to 20.74 years for women. The number of expected years with care needs was between 1.70 and 1.73 years for men and between 3.59 and 3.66 years for women.

The elimination of malignant neoplasms and heart diseases led to some gains in the number of expected years with and without care needs (between 0.20 and 2.45 years); these gains decreased each subsequent year. The elimination of cerebrovascular diseases led to some gains in the expected years without care needs (between 0.75 and 1.08 years) and some losses in the expected years with care needs (between – 0.08 and – 0.31 years). These gains and losses compressed each year. The elimination of dementia led to gains in expected years without care needs (between 0.23 and 0.87 years) and losses in the expected years with care needs (between –

0.18 and - 0.69 years); these gains and losses expanded each year. The elimination of arthropathies led to gains in expected years without care needs (between 0.05 and 0.21 years) and losses in the expected years with care needs (between - 0.04 and - 0.19 years); the gains and losses compressed each year.

Table 3

Baseline and gains in life expectancy, expected years with and without care needs at age 65 years, after elimination of selected diseases (2010, 2013, and 2016) in Japan

			Baseline	Gains from the elimination of:				
				malignant neoplasms	heart diseases	cerebrovascular diseases	dementia	arthropathies
Men								
Life expectancy at age 65, years								
Year:	2010	18.86	3.03	1.16	0.77	0.04	0.01	
	2013	19.08	2.95	1.10	0.67	0.06	0.01	
	2016	19.55	2.94	1.08	0.59	0.08	0.01	
Expected years without care needs at age 65, years								
Year:	2010	17.15	2.45	0.90	1.08	0.23	0.05	
	2013	17.38	2.40	0.91	0.96	0.29	0.05	
	2016	17.82	2.40	0.88	0.86	0.35	0.05	
Expected years with care needs at age 65, years								
Year:	2010	1.70	0.58	0.26	-0.31	-0.18	-0.05	
	2013	1.70	0.55	0.20	-0.29	-0.23	-0.05	
	2016	1.73	0.54	0.21	-0.28	-0.27	-0.04	
Women								
Life expectancy at age 65, years								
Year:	2010	23.89	2.03	1.59	0.92	0.10	0.02	
	2013	23.97	1.97	1.42	0.77	0.14	0.02	
	2016	24.38	1.99	1.32	0.66	0.18	0.02	
Expected years without care needs at age 65, years								
Year:	2010	20.24	1.33	0.84	1.00	0.65	0.21	
	2013	20.38	1.30	0.79	0.89	0.74	0.16	
	2016	20.74	1.33	0.75	0.75	0.87	0.15	
Expected years with care needs at age 65, years								
Year:	2010	3.66	0.71	0.76	-0.08	-0.56	-0.19	
	2013	3.59	0.66	0.63	-0.12	-0.60	-0.14	
	2016	3.65	0.66	0.57	-0.08	-0.69	-0.13	

Discussion

We found that the elimination of dementia, cerebrovascular diseases, and arthropathies led to some gains in expected years without care needs and some losses in the expected years with care needs at age 65 years, and that the elimination of malignant neoplasms and heart diseases led to gains in both expected years without and with care needs among older populations in Japan. Although the elimination of these diseases is hypothetical and not realistic, our findings demonstrate the burden of these diseases on expected years with and without care needs.^{1,18} Our findings imply that the prevention of dementia, cerebrovascular diseases, and arthropathies is important in planning measures for reducing the number of expected years with care needs among older people.⁷

We revealed that the gains in expected years without care needs and losses in expected years with care needs from the elimination of dementia expanded with each subsequent year during 2010–2016 in Japan, and those from the elimination of cerebrovascular diseases and arthropathies compressed with each year. These results suggest that the impact of dementia increases and the impact of other diseases decreases over time, which can serve as a target of measures aiming to reduce the expected years with care needs.

The results observed in the present study were based on the prevalence of care needs, as well as death rates.^{1,18} As shown in Table 2, dementia, cerebrovascular diseases, and arthropathies led to a high proportion of patients with care needs and malignant neoplasms and heart diseases led to a lower proportion. The proportion of patients with care needs in dementia increased with each year and that in cerebrovascular diseases and arthropathies decreased. It has been reported that dementia, cerebrovascular diseases, and arthropathies are major causes of care needs and the impact of dementia increases each year in Japan.^{16,21–23} The present study provided no information regarding the reasons for these trends.

Several previous studies have reported the effects of elimination of several diseases on the expected number of years with disability among older populations.^{1,8,9} In Australia in 1993, the elimination of mental disorders and musculoskeletal disorders led to some losses in the expected years with disability at age 65 years, and the elimination of malignant neoplasms and cardiovascular disease in men led to some gains.¹ In the Netherlands during 1982–1991, elimination of arthritis/back complaints led to losses in the expected years with disability at age 65 years, and the elimination of cancer and heart disease led to some gains.⁸ In Brazil, the elimination of malignant neoplasms, heart diseases, and cerebrovascular diseases showed gains in the expected years with disability at age 60 years among men and losses in women in 2000 and led to losses in both sexes in 2010.^{9,24} Those results are uncommon. One reason for those findings could be that the extent of death and disability from disease varies widely by population and year.

Gains in the expected years with and without activity limitation at birth from the elimination of several diseases in 2007 in Japan have been calculated.¹⁸ That study reported that the elimination of dementia and cerebrovascular diseases led to gains in expected years without activity limitation and losses in expected years with activity limitation. Although activity limitation in that study involved much milder disability than the care needs investigated in the present study, the results were similar to ours.^{6,16,18} That previous study also reported that the elimination of shoulder lesions and lower back pain led to large losses in expected years with activity

limitation. We did not target shoulder lesions and low back pain because these diseases are not primary causes of either death or nursing care needs.¹⁶

There are some limitations in the present study. We calculated the expected years with and without care needs by the elimination of diseases, using a previously proposed method.^{17,18,20} Although it is assumed that the age-specific prevalence of care needs in the stationary population is equivalent to that observed in the real population, the method has been applied in many studies.^{2-6,9-11} We used long-term care insurance data of Japan and classified level 2 of care or greater as having care needs.¹² The data source and classification were the same as in a previous study.⁶ The coverage of care needs in the insurance system would be sufficiently high and stable.^{6,12} We selected the five diseases, including malignant neoplasms, heart diseases, and cerebrovascular diseases, which are leading causes of death in Japan.¹³ Dementia, cerebrovascular diseases, and arthropathies are primary causes of nursing care needs in Japan.¹⁶ However, targeting other diseases would also be important.

The underlying cause of death was used in the present study. If deaths indirectly caused by a disease were not considered, the total effects of the disease on death rates would be underestimated.^{13,25} The underestimation of the malignant neoplasms, heart diseases, and cerebrovascular diseases selected in the present study would be relatively small, unlike that of hypertension and diabetes.²⁶ A primary causative disease leading to care needs was used.¹⁶ Similar to use of the underlying cause of death, this would result in underestimating the total effects of diseases on the prevalence of care needs. Nevertheless, the problem of using an underlying cause of death and a primary causative disease of care needs is common in many studies.^{1,9-11,18}

We assumed that the proportion of individuals with care needs primarily caused by disease among those with care needs living at home was equal to the proportion among all individuals with care needs, including residents in health care and welfare facilities for older people requiring long-term care, by sex, age and care needs level group. In the present study, we used data on primary causative disease leading to care needs among individuals with care needs living at home obtained from the Comprehensive Survey of Living Conditions.¹⁶ Data for residents in health care and welfare facilities for older people requiring long-term care were unavailable. Many people with care needs were living at home, and about 23% were resident in these facilities during 2016 in Japan.^{15,27} It is important to examine the above assumption.

Conclusions

In conclusion, our results suggest that the prevention of dementia, cerebrovascular diseases, and arthropathies lead to more expected years without care needs and fewer expected years with care needs. The impact of dementia might increase and that of other diseases might decrease each year.

Abbreviations

ICD-10: International Classification of Diseases, Tenth Revision

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets analyzed in this study are not available because we used data from the Comprehensive Surveys of Living Conditions with permission from the Ministry of Internal Affairs and Communications and the Ministry of Health, Labour and Welfare of Japan.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was supported by a by a Grant-in-Aid for Comprehensive Research on Cardiovascular and Lifestyle-Related Diseases from the Ministry of Health, Labour and Welfare, Japan [grant number H31-Junkankitou-Shitei-001]. The funder had no role in research design, information collection, data analysis, interpretation of data and the preparation of the manuscript.

Authors' contributions

IT and SH conceptualized the study. SH and MK designed the study. MK and SH analyzed data and draft the manuscript. TO, RS and HY contributed to the interpretation of data. All authors provided critical feedback and approved the final manuscript.

Acknowledgements

We thank Analisa Avila, ELS, of Edanz Group (<https://en-author-services.edanzgroup.com/ac>) for editing a draft of this manuscript.

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