

ORIGINAL ARTICLE

Hypertension and life expectancy among Japanese: NIPPON DATA80

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Life expectancy (LE) is a measure that describes the health status of a population. The few published studies that have examined the impact of hypertension on LE were predominantly performed in Western populations. The effect of hypertension on LE has not been reported in an Asian population. Thus, we examined the impact of hypertension on LE in the Japanese population, which has the highest LE worldwide. The abridged life table method was applied to calculate the LEs of both normotensive and hypertensive men and women aged 40–85 years. Hypertensive participants were categorized as having either stage 1 or stage 2 hypertension. Age-specific mortality rates across different groups were estimated using the person-year method based on the follow-up data from a representative Japanese population in a national survey (NIPPON DATA80). The proportion of hypertensive patients in the baseline survey was 50.5% for men and 41.4% for women. The LE of 40-year-old men and women was 41.7 years and 48.7 years, respectively, in normotensive participants and 39.5 and 45.8 years, respectively, in hypertensive participants. The LE difference between normotensive and hypertensive participants was 2.2 years for men and 2.9 years for women. LE decreased with increasing stages of hypertension. Similar patterns of LE, with respect to blood pressure (BP) status, were observed in all index ages and for both genders. At the population level, hypertension leads to decreased LE and affects both genders similarly. Our findings highlight the importance of preventing high BP and the consequences of hypertension in Japanese population.

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INTRODUCTION

Studies have shown that hypertension, or high blood pressure (BP), is quite prevalent worldwide¹ and is a major risk factor for morbidity and mortality in young, middle-aged and elderly individuals of both genders.^{2–4} Moreover, hypertension is also closely linked to the aging process, as the prevalence and the risk of hypertension increase with age.^{5,6} A similar influence of age is also found with regard to mortality.^{7,8} The measure life expectancy (LE), which is a comprehensive estimate of a given population's health status, provides a useful and direct means to communicate disease burden and can be used as a universal measure of health in a population. This information can be used to prioritize planning and policy making for the detection, treatment and control of various health conditions.

There are few published studies that have investigated the impact of hypertension on LE.^{9–11} Although the impact of hypertension on premature death and LE has been estimated in Western populations,

the effect of hypertension on LE has not been reported in Asian populations, including the Japanese population. This information will be of importance because it is unclear how hypertension affects LE in the Japanese population, which currently has the highest longevity worldwide. The present study examined the LE of a representative sample of Japanese population in which hypertension status varied. This is the first population-based Japanese study of LE for people with and without hypertension.

METHODS

Data source

The present study analyzed data from NIPPON DATA80 (National Integrated Project for Prospective Observation of Non-communicable Disease and its Trends in the Aged), which was collected from a baseline survey performed in 1980. The details of this cohort have been reported elsewhere.^{3,12,13} In brief, 300 areas were selected by stratified random sampling from all over Japan, and

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a sample of residents aged 30 years or older in these areas was invited to participate. A total of 10 546 residents (4639 men and 5907 women) participated in the survey (response rate: 76.6%). The baseline surveys were carried out at local public health centers. The participants were followed for 24 years, until November 2004.

To identify death events among the cohort, we used national vital statistics. In accordance with Japan's Family Registration Law, all death certificates issued by the medical doctors are to be forwarded to the Ministry of Health, Labor and Welfare via the public health centers in the respective participant's area of residency. We confirmed death in each area by computer matching of vital statistics data using area, sex, date of birth and date of death as key codes. Permission to use the national vital statistics was obtained from the Management and Coordination Agency of the Government of Japan. In the present study, we excluded participants who had missing information at baseline or who were lost to follow-up ($n = 941$). Thus, the final sample consisted of 9605 participants (4228 men and 5377 women). There were no significant differences between the participants who were lost to follow-up and those who were included in the current study in terms of several risk factors. Approval for this study was obtained from the Institutional Review Board of Shiga University of Medical Science (no. 12-18 2000).

BP measurement and categories

Baseline BP was measured by trained observers using a standard mercury sphygmomanometer on the right arm of seated participants after at least 5 min of rest. Hypertension was defined as systolic BP ≥ 140 mm Hg and/or diastolic BP ≥ 90 mm Hg and/or taking antihypertensive medication. Participants with BP < 140 mm Hg and diastolic BP < 90 mm Hg were defined as normotensive. We further categorized the hypertensive participants, without regard to the use of antihypertensive medication, according to the classification by the JNC-7¹⁴ as follows: stage 1 hypertension, systolic BP 140–159 mm Hg and/or diastolic BP 90–99 mm Hg, or stage 2 hypertension, systolic BP ≥ 160 mm Hg and/or diastolic BP ≥ 100 mm Hg. We decided not to consider treatment of hypertension in the categorization of our analyses because we wanted to evaluate the effect of increased BP levels, which can also arise in hypertensive patients under treatment. When the systolic and diastolic pressures fell into different categories, the higher category was selected for the purposes of classification.

Statistical analysis

Age-specific mortality rates for the cohort participants were calculated using the person-year method,¹⁵ and age was considered in the timescale with synchronization with the follow-up. The age bands used in this calculation were defined in 5-year increments. The age categories began at age 40–44 years, and the highest age category was set at age 85 years and over. The abridged life table method was used to calculate life expectancies using age-specific mortality rates. The fraction of the last age interval of life^{13,16} was used to construct an abridged life table. Those fractions were calculated from a complete life table for the year 1990 in Japan.¹³ Each LE was calculated from age 40 to age 85 in 5-year intervals. We also calculated 95% confidence intervals for LE in each age group. All of the statistical analyses were performed using SAS release 9.2 (SAS Institute Inc., Cary, NC, USA).

RESULTS

Table 1 shows the basic characteristics of the participants with different hypertension statuses in the baseline survey. The proportion of hypertensive participants in the baseline survey was 50.5% for men and 41.4% for women. In men, 13.5% of the participants had stage 1 hypertension and 36.2% of the participants had stage 2 hypertension. In women, the respective proportions were 15.0% and 25.1%. Hypertensive patients were generally older and had higher mean plasma glucose and higher total blood cholesterol levels. This difference was observed in both men and women.

The overall LE of the 40-year-old participants, regardless of BP status, was 40.4 years for men and 47.0 years for women. These LE values were higher than the LEs in the complete life table for Japan

from 1990. In that table, LE was 37.5 years for men and 42.9 years for women.¹⁷ The observed differences were consistent across all age groups in both genders. Table 2 shows the LE among the participants with different BP statuses from age 40 to 85 years and over. LEs in 40-year-old men and women were 41.7 years and 48.7 years, respectively, in normotensive participants and 39.5 years and 45.8 years, respectively, in hypertensive participants. Thus, the LEs of 40-year-old normotensive participants were greater than those of hypertensive participants. Similar patterns of LE with respect to BP status were observed in all the age groups. The LEs in men with stage 1 hypertension were greater than those of men with stage 2 hypertension. Similar results were observed in women. The longer LE for participants with stage 1 hypertension in comparison with participants with stage 2 hypertension was observed across all age indices for both genders.

DISCUSSION

In this study, LE was estimated for Japanese men and women with and without diagnosed hypertension. The results attribute a significant loss of LE to hypertension. To the best of our knowledge, this is the first study to report the effect of the presence or absence of hypertension on LE in a Japanese population. We observed that the LE of hypertensive men and women was 2–3 years shorter than the LE of normotensive men and women, especially in the middle-aged categories. Increases in hypertension stage also inversely affected LE.

Similar to our observation, Loukine *et al.*¹¹ recently reported a 2–3 years difference in LE associated with hypertension in a Canadian population. They estimated the LE in 40-year-old men and women to be 41.9 years and 45.8 years, respectively, in normotensive subjects and 38.8 years and 43.7 years, respectively, in hypertensive subjects. After estimating the effect of hypertension on LE in an eastern Finland population, Kiiskinen *et al.*¹⁰ reported that LE was shortened by 2.7 years in hypertensive men and 2.2 years in hypertensive women. Franco *et al.*,⁹ studying the participants in the Framingham Heart Study, reported that the differences in LE between 50-year-old normotensive and hypertensive subjects were 5.1 years in men and 4.9 years in women. They estimated the LE in 50-year-old men and women to be 29.7 years and 34.3 years, respectively, in normotensive subjects and 24.6 years and 29.4 years, respectively, in hypertensive subjects. The effect of hypertension on LE in the Framingham Heart Study was much greater than in our Japanese study, the Canadian study and the Finish study. We also observed that the LE for women is higher than that for men, a direct result of higher mortality among men. A similar pattern was observed for the populations both with and without hypertension. Similar observations were reported for the Canadian population, for both subjects with and without hypertension. We observed that the reduction in LE was larger for men than for women. The estimates from other studies were also consistent: the decrease in LE was greater for men than for women.^{10,11} It is important to note that direct comparability with our results was hampered by differences in methodology, data used, reporting year and characteristics of the populations studied. Among the subcategories of hypertension, stage 1 and stage 2, decreases in the LE of 40-year-olds were observed as the hypertension grade increased. This tendency was less pronounced when we measured LE in the older-age groups. This finding might be attributed to the small sample size of the older-age group.

Regarding the effect of hypertension on the LE of the elderly population, we observed that the presence of hypertension was associated with reduced LE. Severe hypertension led to reductions in LE. However, the overall impact of milder hypertension was much

Table 1 The basic characteristics of Japanese with different hypertension status in the baseline, NIPPON DATA80, Japan

Gender	Variables	Blood pressure categories			
		No hypertension	Hypertension	Hypertension	
				Stage 1	Stage 2
Men	Age, years (s.d.)	45.9 (11.9)	55.4 (12.9)	56.6 (13.2)	54.8 (12.7)
	BMI, kg m ⁻² (s.d.)	22.1 (2.8)	22.9 (2.9)	22.3 (2.7)	23.1 (3.0)
	Height, cm (s.d.)	163.5 (19.5)	161.5 (19.3)	162.1 (35.8)	161.3 (6.5)
	Weight, kg (s.d.)	59.0 (19.5)	59.6 (9.5)	56.8 (9.0)	60.3 (9.5)
	Plasma glucose, mg dl ⁻¹ (s.d.)	98.3 (29.2)	106.4 (35.3)	107.3 (37.0)	105.8 (34.4)
	Total cholesterol, mg dl ⁻¹ (s.d.)	183.9 (31.9)	188.1 (33.7)	183.9 (31.7)	189.7 (34.1)
	Serum creatinine, mg dl ⁻¹ (s.d.)	1.0 (0.1)	1.1 (0.3)	1.1 (0.2)	1.1 (0.3)
	Smoking, <i>n</i> (%)				
	Never smoker	357 (17.1)	417 (19.5)	95 (16.7)	315 (20.6)
	Current smoker	1388 (66.3)	1268 (59.4)	357 (62.7)	896 (58.5)
	Ex-smoker	346 (16.5)	445 (20.8)	116 (20.4)	316 (20.6)
	Unknown	2 (0.1)	5 (0.2)	1 (0.2)	4 (0.3)
	Drinking, <i>n</i> (%)				
	Never drinker	467 (22.3)	377 (17.7)	125 (22.0)	249 (16.3)
	Current drinker	1520 (72.6)	1613 (75.6)	403 (70.8)	1187 (77.5)
	Ex-drinker	104 (5.0)	141 (6.6)	41 (7.2)	91 (5.9)
	Unknown	2 (0.1)	4 (0.2)	0 (0.0)	4 (0.3)
Women	Age, years (s.d.)	45.8 (11.7)	58.8 (12.1)	58.7 (12.0)	57.9 (12.3)
	BMI, kg m ⁻² (s.d.)	22.2 (3.1)	23.8 (3.6)	23.3 (3.4)	24.0 (3.7)
	Height, cm (s.d.)	151.2 (5.8)	148.3 (6.2)	148.2 (6.0)	148.4 (6.2)
	Weight, kg (s.d.)	50.8 (7.7)	52.4 (9.1)	51.2 (8.6)	53.1 (9.2)
	Plasma glucose, mg dl ⁻¹ (s.d.)	96.7 (24.3)	107.0 (33.4)	108.2 (35.7)	106.4 (32.4)
	Total cholesterol, mg dl ⁻¹ (s.d.)	185.5 (32.7)	199.6 (34.3)	197.7 (33.9)	200.3 (34.6)
	Serum creatinine, mg dl ⁻¹ (s.d.)	0.8 (0.1)	0.9 (0.2)	0.9 (0.3)	0.9 (0.2)
	Smoking, <i>n</i> (%)				
	Never smoker	2801 (89.2)	1968 (88.4)	705 (87.6)	1201 (89.0)
	Current smoker	280 (8.9)	194 (8.7)	76 (9.4)	113 (8.4)
	Ex-smoker	56 (1.8)	63 (2.8)	23 (2.9)	36 (1.7)
	Unknown	5 (0.2)	1 (0.0)	1 (0.1)	0 (0.0)
	Drinking, <i>n</i> (%)				
	Never drinker	2405 (76.3)	1818 (81.7)	674 (83.7)	1084 (80.3)
	Current drinker	698 (22.2)	363 (16.3)	118 (14.7)	236 (17.5)
	Ex-drinker	43 (1.4)	40 (1.8)	13 (1.6)	25 (1.6)
	Unknown	5 (0.2)	5 (0.2)	0 (0.0)	5 (0.4)

Abbreviations: BMI, body mass index; NIPPON DATA80: National Integrated Project for Prospective Observation of Non-communicable Disease and its Trends in the Aged; s.d., standard deviation.

more limited. Given the aging of the Japanese population and that of the worldwide population, these LE findings reemphasize the importance of hypertension control, even in the elderly.

Our finding is generalizable to the Japanese population by virtue of the cohort we used for the LE estimation. The NIPPON DATA80 cohort was initially selected by stratified random sampling throughout Japan as part of a national survey. Comparing our results with the complete life table for the same period in Japan,¹⁷ the overall LE of 40-year-old participants, regardless of BP status, was 40.4 years for men and 47.0 years for women. These were higher than the LEs from the complete life table in Japan in 1990, which were 37.5 years for men and 42.9 years for women. The LEs that we measured were greater than those from the complete life table. This difference might be attributed to the overall healthier status of our cohort. In the baseline survey, people with health problems, such as residents of long-term care facilities, could not participate in the survey. This exclusion criterion may have caused age-specific mortality rates to be lower than population as a whole, which could have resulted in the LE

differences observed in this study. The stable population in the final age interval (age 85 and over) was calculated as the number of survivors 85 years or older divided by their death rate. Although this is an accepted way to analyze the final age interval for LE calculations, it may overestimate LE.^{13,18} This overestimation also influences the difference between our results and those from the complete life table.

Possible misclassifications of long-term BP categories might also influence our results. The classification of hypertension status was made using only the information obtained from the baseline survey, with the assumption that individuals' hypertension status did not change during the follow-up period. This assumption would be violated if any normotensive participant became hypertensive with ageing. It is not possible to precisely ascertain how much change in hypertensive status occurred during the 24-year period. The influence of this misclassification might attenuate the LE differences observed among the groups, and misclassification might render our estimates more conservative. It should also be recognized that all of the LE differences observed in this study were not caused by hypertension

Table 2 Life expectancies of Japanese with different blood pressure status from NIPPON DATA80, 24-year follow-up, 1980–1999, Japan

		Blood pressure categories							
		No hypertension				Hypertension			
		No hypertension		Hypertension		Stage 1		Stage 2	
Gender	Index age (years)	LE	95%CI	LE	95%CI	LE	95%CI	LE	95%CI
Men	40	41.7	(41.0, 42.5)	39.5	(38.8, 40.3)	40.6	(39.2, 42.0)	39.2	(38.3, 40.1)
	45	36.9	(36.1, 37.7)	34.8	(34.1, 35.5)	35.6	(34.2, 37.0)	34.6	(33.8, 35.4)
	50	32.3	(31.6, 33.1)	30.5	(29.9, 31.1)	31.3	(30.0, 32.5)	30.3	(29.6, 31.0)
	55	27.8	(27.1, 28.5)	26.0	(25.4, 26.5)	26.9	(25.8, 28.1)	25.7	(25.0, 26.4)
	60	23.4	(22.7, 24.2)	21.9	(21.4, 22.4)	22.9	(21.9, 24.0)	21.6	(21.0, 22.2)
	65	19.4	(18.7, 20.1)	17.9	(17.4, 18.4)	18.6	(17.7, 19.6)	17.7	(17.1, 18.2)
	70	15.6	(14.9, 16.2)	14.2	(13.7, 14.6)	15.1	(14.3, 16.0)	13.9	(13.3, 14.4)
	75	12.2	(11.6, 12.8)	11.0	(10.6, 11.4)	11.7	(11.0, 12.5)	10.7	(10.2, 11.2)
	80	9.2	(8.7, 9.8)	8.5	(8.2, 8.9)	9.2	(8.6, 9.8)	8.3	(7.9, 8.7)
	85	7.2	(6.8, 7.7)	6.6	(6.4, 6.8)	7.1	(6.7, 7.5)	6.4	(6.2, 6.7)
Women	40	48.7	(48.0, 49.3)	45.8	(45.0, 46.6)	47.0	(45.9, 48.2)	44.9	(43.9, 46.0)
	45	43.9	(43.2, 44.5)	41.0	(40.3, 41.7)	42.0	(40.9, 43.2)	40.2	(39.3, 41.2)
	50	39.1	(38.5, 39.7)	36.5	(35.9, 37.1)	37.3	(36.3, 38.3)	35.9	(35.1, 36.7)
	55	34.3	(33.7, 35.0)	32.0	(31.4, 32.5)	32.9	(32.0, 33.7)	31.3	(30.5, 32.0)
	60	29.8	(29.2, 30.4)	27.6	(27.1, 28.0)	28.3	(27.5, 29.0)	26.9	(26.2, 27.5)
	65	25.3	(24.7, 25.9)	23.1	(22.7, 23.6)	23.7	(22.9, 24.4)	22.5	(21.9, 23.1)
	70	21.0	(20.4, 21.6)	19.0	(18.6, 19.5)	19.6	(18.9, 20.2)	18.5	(17.9, 19.0)
	75	17.1	(16.5, 17.6)	15.1	(14.7, 15.5)	15.4	(14.8, 16.0)	14.7	(14.2, 15.1)
	80	13.5	(13.0, 14.0)	11.8	(11.4, 12.1)	12.1	(11.6, 12.5)	11.3	(10.9, 11.7)
	85	10.5	(10.1, 11.0)	9.1	(8.9, 9.4)	9.2	(8.7, 9.4)	8.9	(8.6, 9.1)

Abbreviations: CI, confidence intervals; LE, life expectancy; NIPPON DATA80, National Integrated Project for Prospective Observation of Non-communicable Disease and its Trends in the Aged. Hypertension stages are based on blood pressure measurement, irrespective of medication.

status alone; in fact, other factors in addition to hypertension also affected the mortality rate. The LE differences among the hypertension categories result from the hypertensive participants' risk factor profile, not from BP alone. Thus, in addition to hypertension, other factors simultaneously influenced the LE in our population, including smoking habits,¹³ diabetes mellitus¹⁹ and dyslipidemia. Alternatively, hypertension is a convenient marker that functions as a surrogate for health risks not controlled for in the analysis.

In conclusion, the LEs of participants with different hypertension statuses were examined using data from a nationwide cohort study in Japan. A gradual decrease in LE was observed when hypertension was present, and the decrease was greater with increasing disease severity in both men and women.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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APPENDIX

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