

## Original Article

**Systolic Blood Pressure Percentile Curves for Rural Japanese Men and Women Aged 20 to 79 Years in 1980 and 2005**Akiko Morimoto<sup>1,2</sup>, Yuko Ohno<sup>1</sup>, Yukako Tatsumi<sup>1</sup>, Yoshio Nishigaki<sup>3</sup>, Shoichi Mizuno<sup>4</sup>, Shaw Watanabe<sup>5</sup>

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**Abstract**

**Objective:** To establish systolic blood pressure (SBP) percentile curves for adult Japanese men and women, and to compare the curves obtained for the years of 1980 and 2005.

**Methods:** We analyzed data from 8,080 and 5,616 community residents aged 20 to 79 years who had an annual health check-up in 1980 and in 2005, respectively. Age-specific percentile curves for SBP were constructed by using the LMS method. We plotted the 3<sup>rd</sup>, 5<sup>th</sup>, 15<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 85<sup>th</sup>, 95<sup>th</sup> and 97<sup>th</sup> percentile curves and compared the 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentile curves for 1980 and 2005.

**Results:** The SBP percentile values increased with advancing age in both sexes. The 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> SBP percentile values were higher for men than for women in 1980 and in 2005, particularly among young adults. Furthermore, the 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> SBP percentile values largely decreased from 1980 to 2005 in both sexes.

**Conclusion:** We established SBP percentile curves and confirmed SBP percentile values for 1980 and 2005 by age and sex.

**KEY WORDS:** systolic blood pressure, percentile curves, LMS method, Japanese

**Introduction**

Hypertension is a major risk factor for cardiovascular disease, the leading cause of death globally<sup>1-4</sup>. Given that isolated systolic hypertension is known to be an important predictor of death from cardiovascular disease<sup>5,6</sup>, efforts should be focused on preventing this condition. To aid individuals in checking their own systolic blood pressure (SBP), a tool is needed that allows individuals to monitor their SBP values according to age at specific points in time.

Health index percentile curves allow individuals to visually monitor their own health. A body mass index percentile curve that has been established to help prevent obesity has been used in health education and guidance strategies<sup>7-9</sup>. Such curves for SBP percentiles might help individuals to monitor their own SBP and for SBP control to be evaluated in populations. To our knowledge, no efforts have yet been made to create SBP percentile curves catering to Japanese populations.

We aimed to establish SBP percentile curves, and to compare those of Japanese men and women aged 20 to 79 years in the years of 1980 and 2005.

**Method***Study subjects*

We used data derived from health check-ups of 8,080 (3,191 men and 4,889 women) and 5,616 (2,016 men and 3,600 women) community residents aged 20 to 79 years in 1980 and in 2005, respectively, at a central hospital in a rural area of Nagano Prefecture in Japan. We excluded 140 and 24 subjects whose SBP was not measured in 1980 and in 2005, respectively. Consequently, data were analyzed from the remaining 7,940 (3,159 men and 4,781 women) subjects in 1980 and 5,592 (2,009 men and 3,583 women) subjects in 2005. The Ethical Committee of Saku Central Hospital approved the study (21-15).

*Data collection*

A self-administered questionnaire in the health check-up included demographic and other information. SBP was measured by trained nurses using a mercury manometer in the sitting position after at least a 5-min rest both in 1990 and in 2005.

### Statistical analysis

Age-specific percentile curves for SBP were constructed by using the LMS method developed by Cole and Green as described and the data were smoothed using the Akaike minimum ABIC method<sup>10,11</sup>. We calculated and presented the smoothed L ( $\lambda$  for the power in the Box-Cox transformation), M ( $\mu$  for the median) and S ( $\sigma$  for the coefficient of variation) values for each age- and sex-specific point. **Table 1** shows the number of individuals as well as smoothed L, M and S values by age and sex in 1980 and 2005. The equation for the LMS is:

$$Z = \frac{(\text{measurement} / M)^L - 1}{LS}$$

, where Z is the z-score that corresponds to the percentile. We determined the 3<sup>rd</sup>, 5<sup>th</sup>, 15<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 85<sup>th</sup>, 95<sup>th</sup> and 97<sup>th</sup> SBP percentile curves for men and women aged 20 to 79 years and compared the 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentiles curves for 1980 and 2005.

### Results

**Fig. 1** shows the smoothed 3<sup>rd</sup>, 5<sup>th</sup>, 15<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 85<sup>th</sup>, 95<sup>th</sup> and 97<sup>th</sup> SBP percentile curves for men and women aged 20 to 79 years in the years of 1980 and 2005. SBP percentile values increased with age in both sexes in 1980 as well as 2005. However, while 50<sup>th</sup> percentile values exceeded 140 mmHg in both sexes in the age range of 60-69 years in 1980, no 50<sup>th</sup> percentile values exceeded this level in either sex for any age range in 2005.

**Fig. 2** compares SBP percentile curves for men and women in 1980 and 2005. The 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> SBP percentile values were higher for men than for women in both years, particularly in young adults of both sexes, whereas those of older men and women did not significantly differ.

**Fig. 3** compares the SBP percentile curves for 1980 and 2005 by sex. The 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> SBP percentile values largely decreased between 1980 and 2005 in both sexes and the 95<sup>th</sup> percentile values conspicuously decreased, particularly in older men. The 50<sup>th</sup> percentile values decreased more in women than in men.

**Table 1** Systolic blood pressure-for-age charts, LMS parameters of men and women aged 20 to 79 years in 1980 and 2005

Age	1980								2005							
	Men (n=3,159)				Women (n=4,781)				Men (n=2,009)				Women (n=3,583)			
	n	M	L	S	n	M	L	S	n	M	L	S	n	M	L	S
20-24	124	121.82	-0.573	0.099	393	110.49	-0.485	0.083	36	116.64	-0.700	0.104	23	101.74	-0.940	0.092
25-29	255	123.47	-0.627	0.097	287	110.56	-0.417	0.092	52	111.84	-1.426	0.104	75	100.14	-0.994	0.084
30-34	282	124.24	-0.714	0.108	333	112.47	-1.417	0.103	75	114.44	-0.970	0.103	136	101.28	-0.982	0.094
35-39	258	126.50	-0.012	0.114	390	117.43	-1.461	0.102	70	115.83	-1.353	0.105	186	104.23	-0.673	0.102
40-44	316	128.52	-0.532	0.116	458	120.78	-0.766	0.118	104	117.84	-1.140	0.105	222	108.22	-0.837	0.113
45-49	420	132.20	-0.868	0.125	588	126.79	-0.225	0.124	133	120.09	-1.086	0.114	261	111.26	-0.961	0.126
50-54	430	135.17	-0.663	0.127	665	130.51	0.056	0.136	168	122.19	-0.934	0.127	288	115.08	-0.599	0.138
55-59	346	136.16	-0.609	0.137	658	133.32	0.010	0.135	160	125.93	-0.314	0.134	329	118.34	-0.406	0.135
60-64	277	138.76	-0.297	0.128	477	135.84	0.591	0.131	224	127.37	0.243	0.124	439	122.76	-0.218	0.136
65-69	246	142.20	0.377	0.133	321	141.44	0.423	0.129	281	129.12	0.603	0.117	519	124.69	0.156	0.133
70-74	139	145.82	0.684	0.128	151	140.37	-0.159	0.137	363	130.26	0.679	0.114	592	127.05	0.228	0.125
75-79	66	145.66	0.252	0.127	60	143.95	1.081	0.126	343	130.27	0.450	0.122	513	129.21	0.308	0.126

n: number of subjects; M:  $\mu$  for the median; L:  $\lambda$  for the power in the Box-Cox transformation; S:  $\sigma$  for the coefficient of variation.

Systolic Blood Pressure Percentile Curves

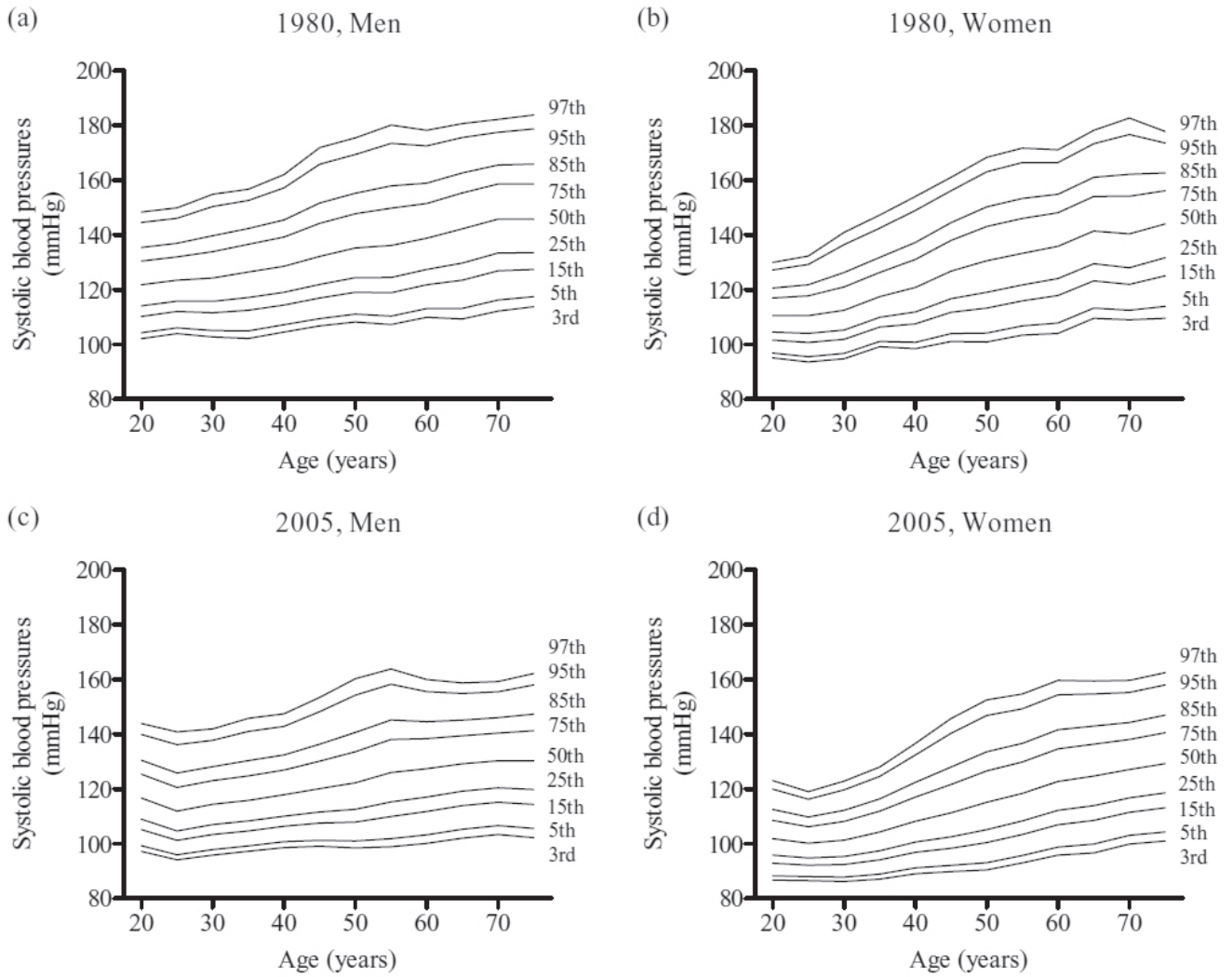


Fig. 1. Smoothed systolic blood pressure percentile curves for men and women aged 20 to 79 years in 1980 and 2005.

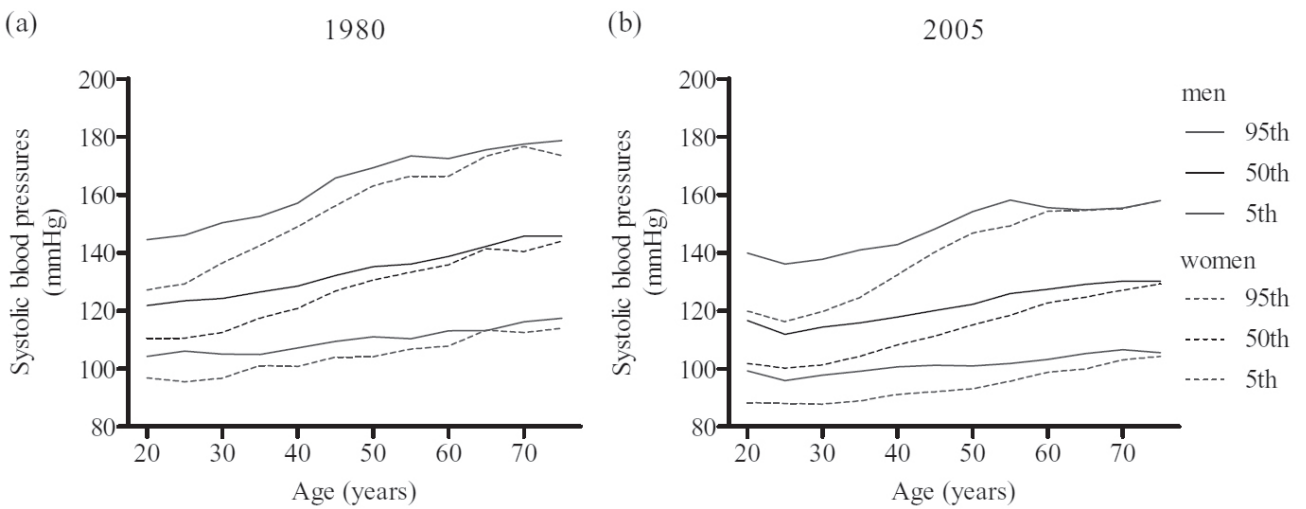
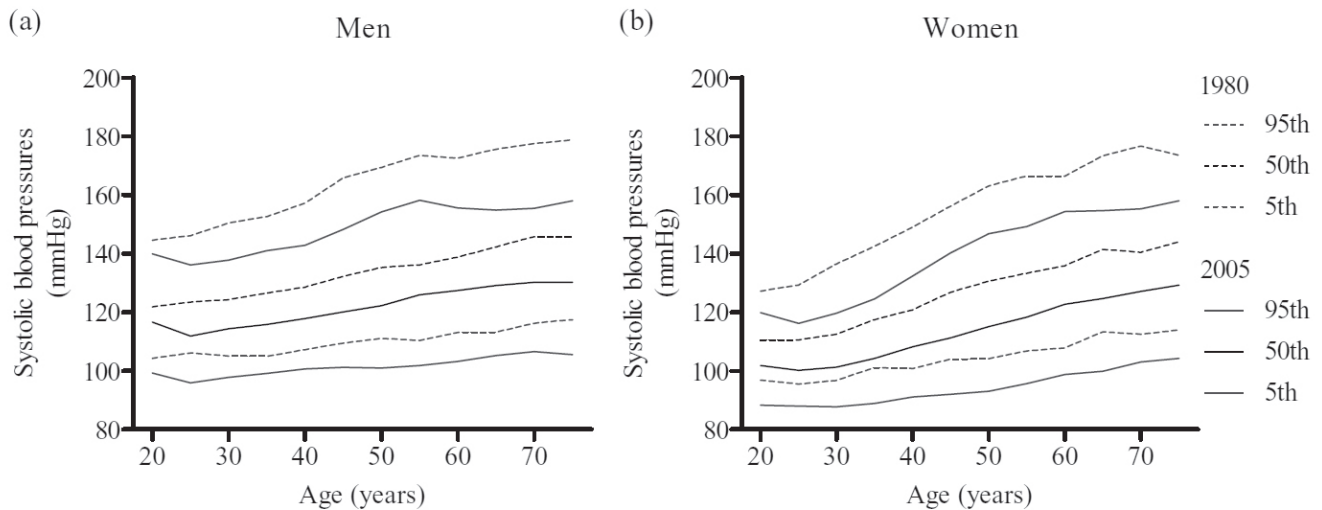


Fig. 2. Comparison between systolic blood pressure percentile curves for men and women in 1980 and 2005.



**Fig. 3.** Comparison between systolic blood pressure percentile curves for 1980 and 2005 by sex.

## Discussion

The present findings indicated that SBP percentile values increased with advancing age in Japanese men and women in 1980 and in 2005. The 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> SBP percentile values were higher for men than for women in both years and largely decreased between 1980 and 2005 in both sexes.

In this study, we confirmed SBP percentile values according to the age, sex and year by establishing SBP percentile curves. These largely decreased between 1980 and 2005 in both sexes. The definition of hypertension changed between 1980 and 2005 to include a lower SBP value<sup>12,13</sup>, following recognition of the need for lifestyle changes to reduce SBP. These actions are thought to have been largely responsible for the decrease in SBP between 1980 and 2005. Physicians and nurses should understand that the age distribution of SBP values varies with time. The SBP percentile curve could visually confirm age distribution at a specific point in time and it might help medical care and health care activity.

Sex differences were found in the SBP percentile curves in both 1980 and 2005. Lifestyle differences between men and women might be associated with this finding because many Asian women, including Japanese women, do not regularly smoke or drink<sup>14,15</sup>. The SBP percentile values of young adult men and women significantly differed. We believe that young adults are not aware of the effect of aging on SBP. Thus, men with high SBP values in particular might benefit from being visually shown the SBP percentile curves. Notably, the SBP percentile values of older men and women did not significantly differ. Therefore, young women with normal SBP should carefully consider the effect of aging on SBP by comparing the percentile curves.

The present study has several limitations. The SBP percentile values obtained for men and women aged 20 to 24 years in 2005 might have a low statistical power because of the small sample size. Selection bias might have been an issue because the data were obtained from community residents who underwent health check-ups and might have been relatively healthy. Thus, the SBP percentile values might be underestimated.

In conclusion, we confirmed SBP percentile values by age and sex for 1980 and 2005 by establishing SBP percentile curves. These curves might be effective as a tool for health education and guidance.

## Acknowledgments

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## Conflict of interest statement:

The authors declare no financial or other conflicts of interest in the writing of this paper.

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