Original Article

A 17-Year Follow-Up Study of Hypertensive and Normotensive Male University Students in Japan

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The aim of the present study was to determine the disease course of hypertensive male university students followed for 8 to 26 years (average, 17 years) after graduation. Subjects were classified into two groups. 1) A hypertensive group (H-group) consisting of 338 conclusively hypertensive male students followed from 1973 to 1990 at the Institute of Health Science, Kyushu University. Their ages ranged from 20 to 27 years, and all had high blood pressure (BP) of 140 mmHg or greater in systole (SBP) and/or 90 mmHg or greater in diastole (DBP) at a regular health check. This was confirmed by BP measurements for 3 days within 1 week. 2) A normotensive control group (N-group) consisting of 732 normotensive students (110−124 SBP/60−74 mmHg DBP) for whom faculty, age, sex, height, weight, and examination period were matched to the H-group as closely as possible. In 1997, each subject was sent a questionnaire with items on height, weight, sitting BP, pulse rate, family history of hypertension, lifestyle habits (such as drinking and smoking), stress and personality type. Completing the questionnaire were 177 (52.4%) of the H-group and 206 (28.1%) of the N-group subjects. Hypertension continued in 44.6% of the H-group subjects, whereas 9.2% of the N-group subjects became hypertensive. The rate of hypertension at the end of the investigation was significantly higher in those subjects who had a family history of hypertension than in those who did not. Weight gain (+15.1%) was the highest in H-group subjects who were initially normotensive. These subjects showed a significantly higher incidence of smoking and drinking than the other subjects. These results confirmed lifestyle to be one of the most important factors in keeping BP normal throughout life and also suggested that fundamental health education should be introduced at an early age. (*Hypertens Res* 2003; 26: 445−452)

***Key Words*: juvenile hypertension, normotension, long-term follow-up study, lifestyle, family history of hypertension**

Introduction

Generally, young adults are considered to be the most healthy, to be in the best physical condition, and to require the least medical care of any Japanese age cohort, as reported in the "1999 Annual Report of the Health and Welfare Statistics Association in Japan." Blood pressure (BP) at a young age has been related to findings later in life (*1*). This "tracking" phenomenon is reported to be more pronounced among Japanese (*2*) and African Americans (*3*) than in other populations.

Since 1973, approximately 7−20% (average, 14%) of the students at the annual regular health check at Kyushu University have been hypertensive according to the criteria of the World Health Organization, which are a systolic (SBP) and diastolic blood pressure (DBP) of 140 and/or 90 mmHg or greater, respectively (*4*). This phenomenon was also reported in the National University White Papers on University Student Health in 1995 (*5*) and 2000 (*6*). The BP of most

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students who were deemed hypertensive at the first regular check had declined to within the normal level at a second medical check performed about 1 month later. However, a small percentage of the students continued to be hypertensive. Despite these findings, there have been no long-term follow-up studies on the natural course of BP in hypertensive university students in Japan, although several follow-up studies have been done in junior high school students (*7*) and high school students (*8*, *9*).

Hypertensive adolescents are said to have a two- to four-fold greater risk of developing fixed hypertension during adulthood than their normotensive counterparts (*10*, *11*). The purpose of this prospective cohort study was to determine the disease course of these sustained hypertensive male students after university graduation and to investigate the influence of family history, lifestyle habits and other factors by comparing the hypertensive subjects with closely matched, normotensive control subjects during the same observation period over an average of 17 years

Methods

Subjects

Subjects were selected from about 42,000 university students who received regular annual health checks at Kyushu University between 1973 and 1990. They were classified into the following two groups.

1) Hypertensive university students (H-group): Three hundred forty-seven sustained hypertensive male students with SBP of 140 mmHg or greater and/or DBP of 90 mmHg or greater were identified and assigned to the H-group. Hypertension at the annual regular health check was confirmed by BP measurement, three times a day for 3 days within 1 week, about 1 month after the regular health check. We defined sustained hypertension as a BP of 140 and/or 90 mmHg or greater at all 10 measurements. Female students meeting the above criteria were excluded from this study because they were only six in number. Each student received a medical check that included urinalysis, chest X-ray and electrocardiogram. No subjects with secondary hypertension were included in the H-group.

2) Normotensive university students (N-group): Seven hundred and eighty-three normotensive students (N-group) (110–124 SBP and 60–74 mmHg DBP) for whom faculty, age, sex, height, weight, and examination period were matched as closely as possible to the H-group served as the controls.

Methods

The regular health check of Kyushu University was performed between April and May each year. It included height, weight, health history, physical examination by a physician, urinalysis (urine pH, protein, sugar, occult blood and urobilinogen), chest X-ray, BP, pulse rates (PR), and electrocardiogram. BP and PR were measured using an automatic electronic sphygmomanometer (first 2 years, USM105 (Ueda Co., Ltd., Tokyo, Japan); thereafter, BP-103PA or BP-103N (Nippon Colin Co., Ltd., Komaki, Japan)) on the right upper arm, with the subject in a sitting position after resting for at least 5 min. Body mass index (BMI) was calculated as weight (kg)/height $(m)^2$.

In the spring of 1997, all subjects were mailed a questionnaire with items on occupation, height, weight, sitting BP and PR (measured at the clinic of their family doctor or at a local health care office), family history of hypertension, present self-evaluated physical condition, lifestyle habits (such as eating, drinking, smoking and sleeping), physical activity, history of hypertension treatment, and personality type. If there was no response to the questionnaire by a member of the H-group, it was re-mailed up to two more times within 6 months.

The questionnaire requested two BP readings and was sent at the same season as the initial check to eliminate seasonal variation. The two BP readings were averaged. For the 30% of N-group and 19% of H-group respondents reporting only one reading, the single reading was used in the analysis.

Family history of hypertension was established based on the results of the questionnaire and was considered positive if at least one parent had been treated for hypertension, was reported to have had a high BP level, or had died from a cerebrovascular disease or hypertensive heart disease. Drinking was regarded as positive when more than 1.5 cups per day of sake was consumed. On average, one cup is 180 ml and contains 15% alcohol. Alcohol intake was further calculated by taking into account the alcohol content of other types of beverages, such as beer, whisky, wine, and shochu, a distilled Japanese drink. The subject was considered a nonsmoker if he had not smoked or had quit smoking for more than 3 years. All subjects were asked to self-evaluate themselves into one of four stress categories (high, moderate, low, and no stress), which were then divided into two groups: a stress (+) (high and moderate) and a stress (−) (low and no stress) group. To evaluate personality, a personality inventory by Friedman and Rosenman (*12*), modified for clinical use in Japan, was used. The type A behavior pattern was surveyed by a triple choice questionnaire form designed by Maeda (*13*). It consists of 12 items related to the type A behavior pattern with the results assessed from total scores. Total scores of 17 points or over were regarded as indicating the type A behavior pattern, according to the criteria (*13*).

Statistical Analysis

Measured variables are expressed as the mean±SD or SEM. Intergroup or intragroup differences in mean values were assessed by nonparametric Wilcoxon's test and χ^2 test. Values of $p<0.05$ were considered to indicate statistical significance.

Results

Baseline Profiles at the Regular Health Check and Second Measurement of Blood Pressure and Pulse Rate

Subject profiles at the time of the regular university health check are shown in Table 1. H-group subjects were 177 former students for whom replies to the 1997 questionnaire were returned. N-group subjects were 206 former students meeting the same criterion. Age ranged from 20 to 27 years at baseline in both groups, and the average age was not statistically different. SBP, DBP and PR in the H-group were significantly higher than the corresponding values of the N-group. Average values of the second, 3-day measurements of BP and PR used for confirmation in the H-group were similar to those at the initial health check, as shown in Table 1.

Table 1. Baseline Profiles of the Hypertensive and Normotensive Groups

Variable	Hypertensive group (H)	Normotensive group (N)
Number	177	206
Age (years)	22.4±1.4	22.1±1.2
Height (cm)	170.7±5.3	170.4±5.0
Weight (kg)	63.8±9.2	63.8±7.4
BMI (kg/m^2)	21.9±2.8	22.0±2.2
Screening (initial health check)		
SBP (mmHg)	154.8±11.4	118.6±4.4***
DBP (mmHg)	78.3±13.2	66.2±4.5***
PR (beats/min)	97.8±19.3	75.1±11.2***
Second measurement†		
SBP (mmHg)	153.8±10.2	
DBP (mmHg)	82.3±11.5	
PR (beats/min)	95.0±17.8	

Data are mean±SD. *** $p<0.001$ (*vs.* hypertensive group (H); by unpaired *t* test). † The average value of the measurement, 3 times a day on 3 days within 1 week, about 1 month after the initial health check. BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; PR, pulse rate.

Currently Hypertensive and Normotensive H-Group Subjects

As shown in Table 2, the H-group was divided into three subgroups: those who had remained hypertensive but had not taken any antihypertensive agents (H-HT(−)), those currently taking antihypertensive agents (H-HT(+)), and those who became normotensive (H-NT). H-HT(−), H-HT(+), and H-NT were 56 (31.6%), 23 (13.0%), and 98 (55.4%) of the 177 H-group subjects, respectively. The results of the initial health check and those of the second BP and PR measurements in the H-group were compared with three current BP categories. The follow-up period, weight, BMI, and PR at the initial check were significantly different among the subgroups. It was of interest that BMI was highest in the H-HT(+) and PR was highest in the H-NT subjects. In the second BP measurement, however, SBP was significantly higher in the H-HT(+) group than in the H-NT group. DBP in the H-HT(+) group was significantly higher than in the other 2 groups.

Table 2. Characteristics of Hypertensive Students at the Initial Health Check and the Data of the Second Blood Pressure Measurement Classified by Current Blood Pressure Status

Variable	H-HT (−)	H-HT (+)	H-NT
Number [%]	56 [31.6]	23 [13.0]	98 [55.4]
Age (years)	22.8±1.6*	22.4±1.3	22.2±1.3
Follow-up period (year)	16.4±5.2	19.0±5.0*,#	15.9±5.4
Height (cm)	170.3±4.7	170.8±6.8	170.9±5.3
Weight (kg)	63.8±8.9	67.7±14.1*	62.9±7.8
BMI (kg/m^2)	22.0±2.7	23.1±4.1*	21.5±2.3
Screening (initial health check)			
SBP (mmHg)	155.8±12.4	156.6±13.2	153.8±10.4
DBP (mmHg)	77.7±13.1	81.7±12.1	77.8±13.6
PR (beats/min)	97.1±19.0	85.4±17.1*	99.9±19.3
Second measurement†			
SBP (mmHg)	156.4±13.7*	156.2±10.9*	152.0±7.4
DBP (mmHg)	82.6±11.8	90.9±11.4***,#	80.3±10.7
PR (beats/min)	93.7±14.3	89.1±21.2	96.4±19.1

Data are mean±SD. * $p<0.05$, *** $p<0.001$ (*vs.* H-NT; by unpaired *t* test). # $p<0.05$ (*vs.* H-HT(−); by unpaired *t* test). H-HT (−), hypertensive group: currently hypertensive without medication. H-HT (+), hypertensive group: currently hypertensive with medication. H-NT, hypertensive group: currently normotensive. † The average value of the measurement, 3 times a day on 3 days within 1 week, about 1 month after the initial health check. Abbreviations are the same as Table 1.

Table 3. Comparison of Body Composition, Blood Pressure and Pulse Rate at the Initial Health Check (A) with the Current Data (B) of the Hypertensive and Normotensive Groups

	A	B	Difference (B−A)
Hypertensive group (H)			
Number	154	154	
Age (years)	22.4±1.4	38.5±5.4$^{\#\#\#}$	16.1±5.3
Height (cm)	170.7±5.1	171.3±5.3$^{\#\#\#}$	0.4±0.8
Weight (kg)	63.3±8.2	68.3±9.5$^{\#\#\#}$	4.4±5.3
BMI (kg/m^2)	21.7±2.5	23.2±2.9$^{\#\#\#}$	1.4±1.8
SBP (mmHg)	154.5±11.2	134.0±11.2$^{\#\#\#}$	−20.5±15.4
DBP (mmHg)	77.8±13.4	82.0±8.0$^{\#\#\#}$	4.3±14.2
PR (beats/min)	98.9±19.1	71.8±9.7$^{\#\#\#}$	−27.0±20.1
Normotensive group (N)			
Number	203	203	
Age (years)	22.1±1.2	38.8±5.0$^{\#\#\#}$	16.8±5.1
Height (cm)	170.5±5.0	171.1±5.1$^{\#\#\#}$	0.6±1.0
Weight (kg)	63.8±7.4	69.2±9.0$^{\#\#\#}$	5.4±7.1
BMI (kg/m^2)	22.0±2.2	23.6±2.7$^{\#\#\#}$	1.7±2.3
SBP (mmHg)	118.6±4.4***	119.3±11.0***	0.7±11.6***
DBP (mmHg)	66.2±4.5***	75.0±9.6$^{***, \#\#\#}$	8.8±10.5***
PR (beats/min)	75.0±11.2***	69.5±10.3$^{*, \#\#\#}$	−5.5±12.1***

Data are mean±SD. A: data at the initial health check; B: current data. Number: subjects regularly taking antihypertensive medicines were excluded (H-group: 23, N-group: 3). $^{*}p<0.05$, $^{***}p<0.001$ (*vs*. corresponding value of H-group; by unpaired *t* test), $^{\#\#\#}p<0.001$ (*vs*. A; by paired *t* test). Abbreviations are the same as Table 1.

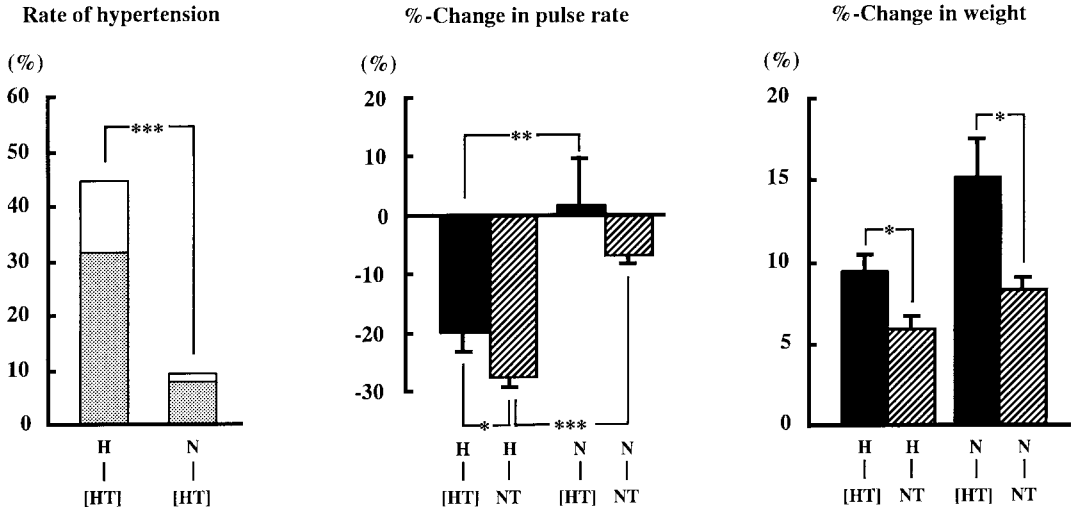

Fig. 1. *Comparison of the percentage of subjects currently hypertensive and percent changes in pulse rate and weight in the H-group (H-[HT] and H-NT) and the N-group (N-[HT] and N-NT). H-[HT] and N-[HT] represent the original H- and N-group students who continued or became hypertensive, with and without antihypertensive drug treatment. H-NT represents the original H-group students who became normotensive, and N-NT, the original N-group students who remained normotensive. For the rate of hypertension, the white (□) and dotted bars (▨) indicate subjects with and without antihypertensive drug treatment, respectively. Black bars (■) indicate the values for students hypertensive at the regular student check-up and shaded bars (▨) the current values for the same subjects. Values are the means±SEM.* $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$ *(by* χ^2 *test).*

Table 3 compares the initial and current status of the H- and N-groups, excluding subjects currently taking antihypertensive agents (H-group: 23 ; N-group: 3). All parameters tested here were significantly different between the initial check-up (A) and the current condition (B) in both the H- and N-groups, except for SBP in the N-group, as shown in

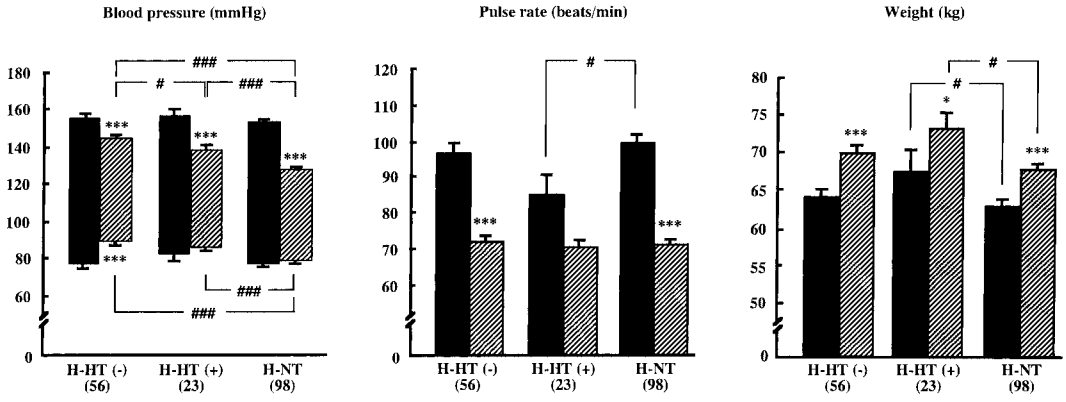

Fig. 2. *Changes in blood pressure, pulse rate and weight of the original H-group subjects who remained hypertensive (H-HT(−) and H-HT(+)), and those who became normotensive (H-NT). The H-group was divided into three subgroups: those who remained hypertensive but had not taken any antihypertensive drugs (H-HT(−)), those currently taking antihypertensive drugs (H-HT(+)), and those who became normotensive (H-NT). Black bars (■) indicate the values for students hypertensive at the regular student check-up and shaded bars (▨) the current values for the same subjects. Values are the means±SEM.* $^{*}p<0.05$, $^{***}p<0.001$ *(by paired* t *test);* $^{\#}p<0.05$, $^{\#\#\#}p<0.001$ *(by unpaired* t *test).*

Table 3.

Comparison of the Rate of Hypertension and %-Changes in Pulse Rate and Weight between the H- and N-Groups

The H-[HT] and the N-[HT] groups represent subjects currently hypertensive, with and without antihypertensive agents. The N-[HT] group consisted of 3 subjects currently taking antihypertensive agents. The frequency (%) of currently hypertensive subjects in the H-group was 44.6% ($n=79$), which included treated (13.0%; $n=23$) and not treated subjects (31.6%; $n=56$). Of the N-group subjects, 19 (9.2%) of 206 became HT (N-[HT]) (Fig. 1). The %-changes in PR and weight in the H- (H-[HT] and H-NT) and the N-groups (N-[HT] and N-NT) are shown in Fig. 1. The %-decrease in PR was greatest in the H-NT group; this value was significantly higher than those of the H-[HT], N-[HT], and N-NT groups. Interestingly, a remarkable decrease in PR was seen in the H-group compared with the N-group. The %-change in weight gain was the greatest (+15.1%) in N-[HT] subjects, and was significantly higher than in N-NT subjects (+8.4%; $p=0.014$). A similar phenomenon was also observed in the H-group (+9.5% in H-[HT] *vs.*+6.2% in H-NT; $p<0.05$).

Changes in Blood Pressure, Pulse Rate and Weight in the H-Group

Changes of BP, PR, and the weight of subjects who became hypertensive (H-HT(−) and H-HT(+)) or who were normotensive (H-NT) at follow-up from the initial H-group are shown in Fig. 2. Both current SBP and PR decreased significantly in the H-HT(−), H-HT(+), and H-NT groups, and current DBP in the H-HT(−) group increased significantly

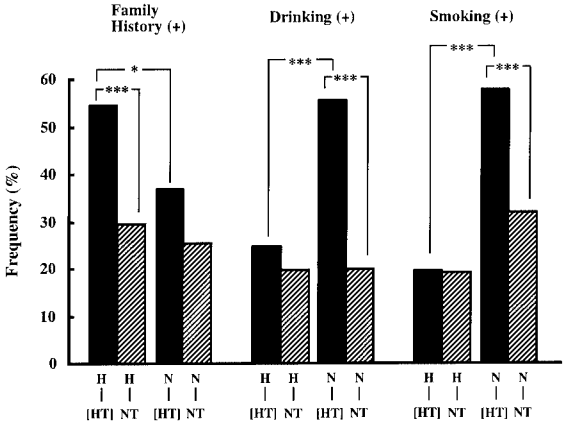

Fig. 3. *Comparison of the frequency of a positive family history of hypertension, drinking, and smoking in the four subgroups. The frequency of a positive family history of hypertension was the highest (54.7%) in the H-[HT] group; this value was significantly higher than those in the H-NT (*$p<0.001$*), N-[HT] (*$p<0.01$*) and N-NT (*$p<0.01$*) subjects. The frequency of both drinking and smoking showed a similar pattern, being significantly higher in the N-[HT] than in the other 3 groups. Black bars (■) indicate the values for students hypertensive at the regular student check-up and shaded bars (▨) the current values for the same subjects.* $^{*}p<0.01$, $^{***}p<0.001$ *(by* χ^2 *test).*

compared with the corresponding values at the initial health check. Current SBP was highest in the H-HT(−) group and lowest in the H-NT group. The current DBP of the H-HT(−) and H-HT(+) groups was significantly higher than that of the H-NT group. PR at the initial check was highest in the H-NT group, significantly higher than that of H-HT(+) subjects. Current weight was also increased significantly in the

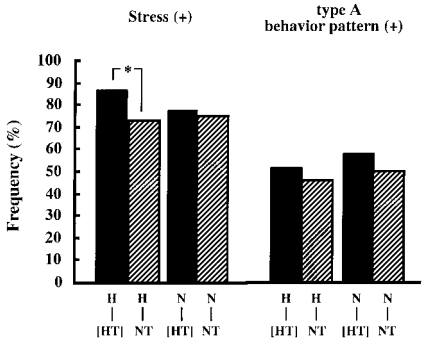

Fig. 4. *Comparison of the frequency of stress (+) and type A behavior pattern (+) in the four subgroups. The highest percentage of stress (+) was found in H-[HT] subjects; this value was significantly higher than that in the H-NT group. The highest percentage of Type A behavior pattern was found in the N-[HT] group, but the differences in this parameter were not statistically significant among groups. Black bars (■) indicate the values for students hypertensive at the regular student check-up and shaded bars (▨) the current values for the same subjects.* * $p < 0.05$ *(by* χ^2 *test).*

H-HT(−), H-HT(+), and H-NT groups compared with the corresponding values at the initial health check. Weight was highest in the H-HT(+) group. Changes of BMI were similar in pattern to those of weight (data not shown).

Family History, Drinking and Smoking in the H- and N-Groups

Figure 3 shows the rates of a positive family history of hypertension, drinking, and smoking of the H- and N-groups. The rate of a positive family history of hypertension was 54.7% in the H-[HT] group; this percentage was significantly higher than those in the H-NT, N-[HT], or N-NT groups. The rates of both drinking and smoking showed a similar pattern, *i.e.*, they were significantly higher in the N-[HT] than in the other 3 groups.

Stress and Personality in the H- and N-Groups

The percentages of subjects reporting stress (+) and a type A behavior pattern (+) in each of the 4 groups are shown in Fig. 4. The highest percentage of stress (+) was found in H-[HT] subjects; this percentage was significantly higher than that in the H-NT group ($p = 0.016$). The highest percentage of Type A behavior pattern was found in the N-[HT] group, but the differences among groups were not significant.

Discussion

No long-term follow-up study of more than 15 years has been done on hypertension in young adults of university age in Japan. Indeed, there have been very few studies on hypertension in young adult subjects in general (*4*, *5*), although many studies concerning children and adolescents can be found. And it is only fairly recently that BP measurement has been added to the regular health check-up of university students in Japan. We have performed BP measurement at our regular health check at Kyushu University since 1972. A strict examination system was established in 1973, allowing data that had accumulated for more than 20 years to be analyzed and followed-up by questionnaire, as was done in this study.

Young adults require repeated measurements to evaluate the reliability and accuracy of an elevated BP reading (*14*). In the present study, hypertensive students were defined as those 140 and/or 90 mmHg or greater at a regular health check. Hypertension was confirmed by measurement 3 times a day for 3 days within the course of a single week, about 1 month after the initial regular health check. The measurements were done in a quiet and nonstressful environment to assure accurate readings. Students for whom the data of all 10 measurements exceeded 140 and/or 90 mmHg were defined as having sustained hypertension at that time. Although no significant differences in either SBP or DBP were found at the initial health check, the average BP of the confirmation 3-day measurements clearly showed the highest values of both SBP and DBP to be in H-HT(+) subjects and the lowest to be in the H-NT group, suggesting the value of repeated measurement of sustained hypertensive subjects, as reported by Weir (*14*).

Although the questionnaire was mailed to the H-group subjects up to 3 times within 6 months, complete replies were received from only 52.4% of hypertensive subjects at the time of the final analysis. The subjects had spread throughout Japan after graduation from the university. Because the rate of subject migration was much higher in the present study than in most cohort studies, the marginal efficiency of the collection rate of the questionnaire was somewhat low in this study, but this problem was counteracted by the sufficiently large number of questionnaires sent in the initial mailing.

The subjects were asked in the questionnaire to have their BP measured twice. Various locations, such as a convenient clinic, hospital, or health care office, were used for this purpose. However, about 19% of H- and 30% of N-group subjects recorded only one measurement. Therefore, the accuracy of the current BP data may not be as reliable as that of the initial check. However, such a discrepancy in reliability cannot be avoided when using a questionnaire for long-term follow-up, and thus is a limitation of any such study.

The tracking phenomenon is said to be more apparent in people 15 years or older than in elementary school children (*15*, *16*). However, in a follow-up study in which 96 of 256 students aged 14–29 years were diagnosed with hypertension (170/100 mmHg or higher), a surprisingly large percentage (35.5%) had spontaneous regression of hypertension without treatment within 20 years, and only 17.1% showed evidence

of progression (*17*). In the present study, the incidence of current hypertension in initially hypertensive students (H-HT) was 50.3%, relatively lower than would be expected if taking into account the tracking phenomenon, which would predict hypertensive students to be at high risk of sustained hypertension. Of the sustained hypertensive students, 55.4% became normotensive after an average 17-year period, and the average BP difference between student age and current status was, surprisingly, more than 20 mmHg. As Zulkifli (*18*) described, the evidence for BP tracking is too weak for BP to be used as a screening tool for the early detection of, or to predict, hypertension. Even if young adults are diagnosed with sustained essential hypertension after repeated measurement, careful attention should be paid to the fact that approximately half might spontaneously become normotensive in the future. Antihypertensive drug therapy and undue medical attention that could create anxiety may not be justified with these subjects.

Remarkably increased PR was observed in most of the hypertensive students at all 10 BP measurements. Young hypertensive subjects are characterized by 1) increased cardiac output; 2) normal peripheral vascular resistance/plasma volume; and 3) increased heart rate, renal blood flow, plasma renin activity, and norepinephrine levels (*14*). These pathophysiologic factors describe a profile of "hyperdynamic circulation" (*19*) or "cardiogenic hypertension" (*20*). In the present study, although the average PR at the health check was nearly 100 beats/min in hypertensive students, it decreased remarkably in the H-group, and especially in the H-NT group (−27.4%), whereas there was little change in the N-group, as shown in Fig. 1. Since elevated plasma catecholamines and increased sympathetic nerve activity may partially contribute to the pathogenesis of juvenile essential hypertension (*21*), the increased PR seen in young adults may have some relation to the level of catecholamines and sympathetic nerve activity, which were not measured in the present study.

White coat hypertension (*22*) should also be considered as a possible cause of the sustained hypertension seen in some of our students. Although white coat hypertension prevalence rises with age (*23*) and is particularly high in elderly patients with isolated systolic hypertension (*24*), we have also seen many younger subjects with white coat hypertension. Our sustained hypertensive subjects may have included some with white coat hypertension, as observed by BP returning to normal in serial self-checks done using automatic BP devices (*25*). We therefore recommend that young adults with mild and sustained hypertension, especially that associated with sinus tachycardia, perform self-measurement using an automatic BP device. This is very useful, not only for their education but also for understanding the characteristics of BP.

There have been many reports on the history of hypertension in parents that emphasize the importance of this risk factor (*26–31*). In young adults, 30–40% of individuals with at least one hypertensive parent will themselves develop hypertension (*30*). In the present study, the highest percentage of subjects with a positive family history was found in the H-[HT] group, indicating that young hypertensive subjects with a positive family history tend to continue the hypertensive state for long periods of time. A high BP level associated with a positive family history early in life strongly predicts future hypertension (*32*).

Numerous reports have also suggested the importance of environmental factors such as weight control, drinking, smoking, and stress in the development or continuation of hypertension. These factors have also been described and summarized in a hypertension textbook by Kaplan (*33*). In a prospective study, Ascherio *et al*. (*34*) reported that relative weight, age, and alcohol consumption were the strongest predictors for the development of hypertension, although this study was done only with women. Interestingly, the %-increase of weight was significantly greater in both N-[HT] and H-[HT] subjects than in either H-NT or N-NT subjects, with the greatest gain seen in the N-[HT] group, suggesting that weight gain is one of the most important risk factors for the development of hypertension. We also confirmed the significance of weight control, and would like to emphasize that education in weight control is important in preventing increases in BP in young adults.

The rates of both drinking and smoking were significantly greater in the N-[HT] group than in the N-NT group. The H-[HT] group self-evaluated significantly more stress than the H-NT group. Although the type A behavior pattern has been closely related to ischemic heart disease (*35*), this behavior pattern may not be strongly influential in the development or continuation of hypertension.

In conclusion, these results confirmed that a family history of hypertension is an important genetic factor in sustained hypertension and that lifestyle is closely related to blood pressure control throughout life. The results suggest that fundamental, routine health education should be introduced at an early age to prevent increases in BP, which is a major risk factor for cerebrovascular diseases.

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