Type A Behavior Pattern and Change in Blood Pressure from Childhood to Adolescence

The Minneapolis Children's Blood Pressure Study

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The association of the Type A behavior pattern with change in blood pressure was examined in a multiethnic sample of schoolchildren. Blood pressure was assessed in 1978 (mean age = 8 years) and approximately biannually thereafter through 1987-1990, when a post-high school screening was completed. The Matthews Youth Test for Health (MYTH) was completed by the teachers of a sample of participants in 1982 (n = 502). The Jenkins Activity Survey (JAS) was completed by all adolescents who participated in the post-high school screening (n = 816). Males were more likely to be classified as Type A than were females by the JAS and the MYTH. Type A status was not associated cross-sectionally with elevated blood pressure. JAS-assessed Type B males had significantly higher mean post-high school fourth- and fifth-phase diastolic blood pressures than did Type A males (70.2 mmHg vs. 68.2 mmHg, p < 0.05; 68.1 mmHg vs. 65.2 mmHg, p < 0.01). JAS-assessed Type A/B status was not associated with 10-year change in blood pressure. MYTH-determined Type B females tended to have higher diastolic blood pressures than MYTH-determined Type A females throughout the 10-year study period. Results from this study did not confirm the hypothesis that Type A participants would have significantly higher blood pressures than Type B participants at the time of Type A assessment; nor did they confirm the hypothesis that Type A participants would exhibit greater increases in blood pressure than Type B participants over a 10-year period. Am J Epidemiol 1996;143:63-72.

The Type A behavior pattern has been described by Friedman and Rosenman (1) as a behavioral-emotive pattern exhibited by individuals who constantly attempt to accomplish more and more in less and less time. Characteristics of this pattern include but are not limited to extremes of time urgency, competitiveness, impatience, and hostility. Individuals who do not display these characteristics are classified as Type B.

With the development and validation of measures designed to assess Type A behavior in children and adolescents (2–7), researchers have begun to examine associations between this pattern and resting blood pressure. The association between resting blood pressure levels and Type A behavior in children and adolescents is not consistent from published reports of cross-sectional data. One study reported a positive association (8), while others reported associations that varied by sex and/or race (9, 10), and still others reported no association between Type A behavior and blood pressure (11–14).

To date, five prospective studies have examined the association between Type A behavior and blood pressure in children, adolescents, or young adults (15–19). Two of the five studies reported a significant association between Type A scores and blood pressure (16, 18). Some of these studies, while prospective in nature, did not use analytic techniques to assess change in blood pressure with increasing age, and only one examined change in blood pressure using more than two blood pressure assessment periods. For example, two of the studies compared Type A scores in a subset of children with consistently high and consistently low blood pressures (17, 18). One study reported change in blood pressure only after one follow-up measurement made 1 year after the first (19). Finally, with the exception of the study by Garrity et al. (16), none of these studies examined the association between Type
A behavior and blood pressure in racial/ethnic groups other than non-Hispanic white.

Given these limitations, we sought to examine change in blood pressure in a large, multiethnic cohort of Type A and Type B children who had had multiple blood pressure assessments over a 10-year period. The purpose of the present analysis was to: 1) determine whether there is a cross-sectional association between Type A status and blood pressure, 2) compare 10-year change in blood pressure among Type A and Type B children, and 3) study a multiethnic sample of children for these comparisons. We hypothesized that Type A children would have significantly higher blood pressures at the time of Type A assessment. Furthermore, we tested the hypothesis that Type A children would experience a greater rise in blood pressure than Type B children over the 10-year study period.

MATERIALS AND METHODS
Sampling methodology and participants

Data were derived from the Minneapolis Children’s Blood Pressure Study, which began in 1978. Details on the study’s sampling methodology have been published elsewhere (20). Briefly, participants were selected from children attending grades 1–3 who were aged 6–8 years at the initial screening. A 100 percent sample of children of race/ethnicity other than non-Hispanic white or African-American was selected to participate, as well as all children in the upper and lower five percentiles of the age-specific population distribution of systolic blood pressure. For each of the three age groups (6, 7, and 8 years), a random sample of one in nine of the remaining non-Hispanic white children and one in two of the remaining African-American children was selected, leading to a total sample size of 2,656 children. After exclusion of 15 autistic children, the remaining 2,641 eligible children and their parents were invited to participate in the first home interview in 1978–1982. A total of 1,509 families responded and participated in that home interview. Although African-American children and their parents were less likely to participate in the home interview, there were no significant differences in blood pressure values between children who did and did not participate in the home interview, irrespective of ethnicity and sex (21).

Three analytic samples were drawn from the Minneapolis Children’s Blood Pressure study to test associations between blood pressure and Type A status: 1) 502 children who were rated by their teachers in 1982 for Type A status; 2) 816 participants who completed a self-report measure of Type A behavior between 1987 and 1990; and 3) 350 participants who had both Type A measures.

Procedure and measures

Blood pressures and anthropometric data were obtained biannually at the child’s school. There were 18 school screening periods altogether. Detailed descriptions of blood pressure assessment procedures have been published elsewhere (22, 23). Briefly, at each screening, a random-zero sphygmomanometer was used to obtain two standardized measurements each of systolic blood pressure and Korotkoff fourth- and fifth-phase diastolic blood pressure (hereafter called DBP-4 and DBP-5). Selected cuff size was based on the child’s arm circumference. Blood pressure readings were taken with the participant supine in the first nine biannual assessment periods. Thereafter, blood pressure readings were taken with the participant seated. The average of the two blood pressures taken at each screening was used in all analyses.

Height and weight, measured using calibrated 1-beam scales, were assessed with the participant wearing indoor clothing without shoes. Body mass index was calculated by dividing weight (kg) by the square of height (m²) (24).

In 1982, teachers of 502 participants fully completed the Matthews Youth Test for Health (MYTH) (4). The 17-item MYTH assesses Type A behaviors such as irritability, speed of activity, competitiveness, impatience, and aggression. The MYTH is the most widely used measure of Type A behavior in children, and its validity has been established in a number of studies (25–28). Interrater reliability and 12-month test-retest reliability range from 0.55 to 0.64 (29, 30) and from 0.48 to 0.55, respectively (25, 31). Internal consistency ranges from 0.88 to 0.90 (25–31).

Participants in the post-high school screening (n = 816), which took place in 1987–1990, completed Form N (for nonemployed individuals) of the Jenkins Activity Survey (JAS), the most widely used self-report measure of Type A behavior (32). The JAS was patterned after the Structured Interview, which was developed during the Western Collaborative Group Study (33). Discriminant function analysis was used to weight individual items on the JAS to predict Structured Interview Type A/B classification. High scores on the JAS, indicating Type A behavior, were predictive of coronary heart disease in the Western Collaborative Group Study (33). Construct validation of the JAS indicates that it measures components of the Type A behavior pattern, such as time urgency and achievement striving, but does not assess hostility (34). Furthermore, despite its being patterned after the Structured Interview, classification agreement between the JAS and the Structured Interview ranges between 65 and 70 percent (35). Because of factor weights used to compute JAS scores, internal consistency reliability is
generally not reported. One-year test-retest reliability ranges from 0.60 to 0.70 (36).

Analyses

Participants were categorized as Type A or Type B on the basis of a median split of the distribution of the MYTH Type A measure and the published Type A/B cutpoint for the JAS (32). Because of the heterogeneity of the Type A construct and the measures used to assess it, it has been suggested that Type A/B categorization be based on multiple Type A measures using different assessment techniques, such as interview and self-report (37). We therefore also constructed a composite index of Type A behavior based on the JAS and the MYTH, because these two measures employ different assessment techniques (i.e., self-report, teacher ratings). Participants classified as Type A by the JAS and the MYTH were classified as Type A, while those classified as Type B by both measures were classified as Type B. The remaining participants were categorized as “mixed.”

Analyses were performed using the BMDP (38) and SAS (39) statistical packages. One-way and two-way analyses of variance, including interaction terms, were used when more than two groups were compared. Categorical data were analyzed using $\chi^2$ analysis. Whenever multiple comparisons were performed, nominal $\alpha$ levels were adjusted using Bonferroni's technique.

For analysis and comparison of profiles of body mass index and profiles of blood pressure, a random-coefficient growth curve model approach was used (40). Major advantages of this approach are that 1) the timing of the measurements over the course of the study does not need to be uniform for all individuals and 2) the pattern of the measurements does not need to be the same for all individuals (41).

The model, which was analyzed using the 5V module of the BMDP statistical package (38), assumes that for each individual his/her blood pressure measurements are a linear function of time of the form

$$BP_{ijk} = a_{ij} + b_{ij}T_k + e_{ijk},$$

where $BP_{ijk}$ is the blood measurement obtained at the $k$th screening for the $j$th individual in the $i$th Type A group; $a_{ij}$ is the random intercept for individual $j$ in group $i$; $b_{ij}$ is the random slope for individual $j$ in group $i$; and $e_{ijk}$ is the error term.

The model assumes that the expected value of $BP_{ijk}$ is given by $E(BP_{ijk}) = a_i + b_iT_k$, where $a_i$ and $b_i$ are, respectively, the population average intercept and slope for the $i$th group. It also assumes that the variance-covariance matrix of the vector of measurements for each individual has a random-effects structure of the form $\Sigma = \Phi \Phi' + \sigma^2 I$, where $\Sigma$ is a matrix whose first column elements are all equal to 1 and the $k$th element of the second column is the elapsed time (in months) from the first measurement to the $k$th measurement.

From the computer program output, one can determine the estimates of the elements of the matrix $\Phi$ and the value of $\sigma^2$. The program also allows for Wald tests of significance for main effects (e.g., the effect of Type A classification on the response variable) as well as interactions. In particular, the Wald test labeled Group $\times$ Time tests the null hypothesis that the slopes are the same for the different Type A groups.

Blood pressure readings were taken with the participants supine during the first nine biannual assessment periods (months 0–60), while readings taken during the remaining assessment periods were taken with the participants seated (months 68–136). Because of the change in blood pressure protocol, we conducted all longitudinal analyses separately for the two assessment periods (i.e., months 0–60 and months 68–136). In addition, the two assessment periods prior to the post-high school screening (months 108 and 120) had low participation rates and were therefore not included in our analyses. These analyses were conducted using data collected during the first nine biannual assessment periods from the first 60 months of the study and the remaining eight assessment periods from months 68–136 of the study.

RESULTS

In the present study, the internal consistency reliability of the MYTH was 0.90. The internal consistency of the JAS was not calculated because of the factor weights used to compute Type A/B scores. There was little agreement in Type A/B classification between these two measures. Twenty-two percent of the sample was classified as Type A by both the MYTH and the JAS, while 39 percent of the sample was classified by both measures as being Type B. Remaining participants were classified as Type A by one measure and Type B by the other measure. Kappa analysis applied to this distribution resulted in an estimated $\kappa$ value of 0.21 (standard error = 0.05), which, although statistically significant ($p < 0.05$), is low and confirms poor agreement between these measures.

Prior to testing our primary hypotheses, we examined potential differences between study participants who were and were not assessed for Type A status. Of the 1,183 participants present in 1982, 42 percent had the MYTH completed by their teachers, while 74 percent present for the 1982 screening subsequently
completed the JAS during the post-high school screening. Presented in table 1 are the sociodemographic characteristics of participants who did or did not have complete Type A assessments but were present for the 1982 blood pressure measurement \((n = 1,183)\). Several statistically significant differences were found when those who did and did not complete the Type A measures were compared. However, the magnitude of these differences was not large. For example, those who had completed the MYTH were younger (11.6 vs. 11.8 years), comprised a lower percentage of children living in households with annual incomes below $20,000 (57 percent vs. 65 percent), and had a lower body mass index (18.7 vs. 19.4) than those who did not have the MYTH scored. Those with a completed MYTH also had a significantly higher systolic blood pressure during the post-high school assessment period than those who did not have the MYTH scored (112.0 mmHg vs. 110.1 mmHg).

A \(\chi^2\) analysis comparing ethnic status in those who did and did not have the MYTH scored by their teacher indicated that the ethnic distribution was significantly different in these two groups. We therefore completed four \(2 \times 2\) \(\chi^2\) analyses to determine which distributions of ethnic groups—African-American, Native American, white, and other—were significantly different in the groups completing and not completing the MYTH. In these analyses, the significance level was adjusted for the multiplicity of the comparisons to \(\alpha = 0.01\). Results indicated that those who had the MYTH completed comprised a significantly higher percentage of whites (66 percent vs. 57 percent) than those who did not. Conversely, those with a completed MYTH comprised a significantly lower percentage of African-Americans (25 percent vs. 33 percent) than those without one.

Persons in the group which completed the JAS comprised a higher percentage of females (49 percent vs. 42 percent) than those who did not. Those completing the JAS also had a lower percentage of children living in households with annual incomes below $20,000 than those who did not (59 percent vs. 67 percent). There were no significant differences in blood pressure assessed in 1982 for those who did and did not complete the JAS.

A \(4 \times 2\) \(\chi^2\) analysis comparing the overall distribution of ethnic status in those who did and did not complete the JAS was significant. Completion of four \(2 \times 2\) \(\chi^2\) analyses revealed one significant finding. Those who completed the JAS comprised a significantly higher percentage of whites (64 percent vs. 53 percent) than those who did not.

Table 2 displays the sociodemographic characteristics and body mass indices of Type A and B participants. Type A children, as assessed by the MYTH, were comprised of lower percentages of females compared with Type B children (33 percent vs. 55 percent). The distribution of ethnic status in MYTH-assessed Type A and B children was significantly different in these two groups. However, computation of \(\chi^2\) values for \(2 \times 2\) tables using an \(\alpha\) level of 0.01 to control for multiple comparisons indicated that the distribution of ethnic status by Type A/B categorization was not significant.

Type A adolescents, as assessed by the JAS, included a lower percentage of females (40 percent vs. 50 percent). Age, household income, and body mass index were not associated with Type A status as assessed by either Type A measure.

Because the percentage of Type A participants was significantly lower among females than among males using both Type A measures, we conducted sex-specific analyses when examining the association between Type A status and blood pressure. Table 3 presents the Type A/B- and sex-specific blood pressures (with standard deviations) at the time of Type A assessment. There was no association between MYTH-assessed Type A status and blood pressure measured in 1982. JAS-assessed Type B male participants had significantly higher sitting diastolic blood pressures (DBP-4 and DBP-5), as assessed at the post-high school screening, than Type A participants \((F = 5.1, \ p < 0.05; \ F = 8.2, \ p < 0.01)\). Sex-specific one-way analyses of variance comparing blood pressures from the post-high school screening among Type A \((n = 79)\), mixed \((n = 136)\), and Type B \((n = 135)\) participants classified by both the MYTH and the JAS also did not yield significant results (data not shown).

Because the percentage of MYTH-assessed Type A children also varied by race (see table 2), we sought to examine potential interaction effects of ethnicity and Type A/B status on blood pressure. Included in each sex-specific analysis of variance model was an interaction term between Type A/B status and ethnicity, categorized as African-American, white, or other. There were no significant interactions between Type A/B status and ethnicity (results not shown). There was only one significant main effect for Type A/B status: MYTH-assessed Type B females had significantly higher diastolic blood pressure (DBP-4) than Type A females \((71.2 \text{ mmHg vs. } 70.0 \text{ mmHg}; \ F = 4.6, \ p < 0.05)\).

Prior to completing analyses of profiles of blood pressure for Type A and B subjects, we sought to identify potentially confounding factors. Body mass index is a known correlate of blood pressure in adolescents (24). Therefore, using a growth curve analysis approach, we compared, within each sex, the body
TABLE 1. Socio-demographic characteristics, body mass indices, and blood pressures of participants present at the 1982 blood pressure measurement, according to completion of the MYTH† and JAS† assessments of Type A behavior (n = 1,183): Minneapolis Children’s Blood Pressure Study, 1978–1990

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>MYTH Complete</th>
<th>MYTH Did not complete</th>
<th>JAS Complete</th>
<th>JAS Did not complete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Mean or %</td>
<td>SD†</td>
<td>No.</td>
</tr>
<tr>
<td>Age (years) in 1982</td>
<td>502</td>
<td>11.8</td>
<td>0.7</td>
<td>681</td>
</tr>
<tr>
<td>% female</td>
<td>502</td>
<td>44%</td>
<td></td>
<td>681</td>
</tr>
<tr>
<td>Ethnicity†</td>
<td>502</td>
<td></td>
<td></td>
<td>681</td>
</tr>
<tr>
<td>African-American</td>
<td></td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native American</td>
<td></td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td></td>
<td>66%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% with an annual household income &lt; $20,000 in 1979</td>
<td>449</td>
<td>57%</td>
<td>3.4</td>
<td>573</td>
</tr>
<tr>
<td>Body mass index§ in 1982</td>
<td>502</td>
<td>18.7</td>
<td>3.4</td>
<td>677</td>
</tr>
<tr>
<td>Supine SBP† (mmHg) in 1982</td>
<td>502</td>
<td>111.6</td>
<td>10.1</td>
<td>681</td>
</tr>
<tr>
<td>Supine DBP-4† (mmHg) in 1982</td>
<td>502</td>
<td>70.4</td>
<td>10.4</td>
<td>681</td>
</tr>
<tr>
<td>Supine DBP-5† (mmHg) in 1982</td>
<td>502</td>
<td>63.1</td>
<td>14.2</td>
<td>681</td>
</tr>
<tr>
<td>Sitting SBP (mmHg) in 1987–1990</td>
<td>350</td>
<td>112.0</td>
<td>11.5</td>
<td>466</td>
</tr>
<tr>
<td>Sitting DBP-4 (mmHg) in 1987–1990</td>
<td>350</td>
<td>66.7</td>
<td>9.6</td>
<td>466</td>
</tr>
<tr>
<td>Sitting DBP-5 (mmHg) in 1989–1990</td>
<td>350</td>
<td>67.0</td>
<td>10.7</td>
<td>466</td>
</tr>
</tbody>
</table>

* p < 0.05; ** p < 0.01; *** p < 0.001.
† MYTH, Matthews Youth Test for Health; JAS, Jenkins Activity Survey; SD, standard deviation; SBP, systolic blood pressure; DBP-4, diastolic blood pressure, fourth Korotkoff phase; DBP-5, diastolic blood pressure, fifth Korotkoff phase.
‡ Significance was assessed by 4 x 2 χ² analysis.
§ Weight (kg)/height (m)².
I Blood pressure data were not available for participants absent from the post-high school assessment.

TABLE 2. Sododemographic characteristics and body mass indices of participants according to Type A/Type B behavior classification: Minneapolis Children's Blood Pressure Study, 1978–1990

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Type A</td>
<td>Type B</td>
</tr>
<tr>
<td></td>
<td>No.† Mean</td>
<td>SD†</td>
</tr>
<tr>
<td></td>
<td>or %</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>262 11.6</td>
<td>0.7</td>
</tr>
<tr>
<td>% female</td>
<td>262 33%</td>
<td></td>
</tr>
<tr>
<td>Ethnicity§</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African-American</td>
<td>262 30%</td>
<td></td>
</tr>
<tr>
<td>Native American</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>262 61%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% with an annual household income &lt; $20,000 in 1979</td>
<td>239 57%</td>
<td>210 57%</td>
</tr>
<tr>
<td>Body mass index†</td>
<td>262 23.9</td>
<td>5.5</td>
</tr>
</tbody>
</table>

* p < 0.05; **p < 0.01; ***p < 0.001.
† MYTH, Matthews Youth Test for Health; JAS, Jenkins Activity Survey; SD, standard deviation.
‡ Sample sizes differ because of variable attendance rates for different examination periods.
§ Significance was assessed by 4 x 2 x 2 analysis.
I Weight (kg)/height (m)².

TABLE 3. Sex-specific mean blood pressures (and standard deviations) of participants at the time of Type A/Type B behavior classification: Minneapolis Children's Blood Pressure Study, 1978–1990

<table>
<thead>
<tr>
<th></th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type A</td>
<td>Type B</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>Blood pressure (mmHg)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supine SBP†</td>
<td>87</td>
<td>111.2</td>
</tr>
<tr>
<td>Supine DBP-4†</td>
<td>87</td>
<td>70.0</td>
</tr>
<tr>
<td>Supine DBP-5†</td>
<td>87</td>
<td>63.5</td>
</tr>
<tr>
<td>Sitting DBP</td>
<td>111</td>
<td>106.1</td>
</tr>
<tr>
<td>Sitting DBP-4</td>
<td>111</td>
<td>66.1</td>
</tr>
<tr>
<td>Sitting DBP-5</td>
<td>111</td>
<td>64.9</td>
</tr>
</tbody>
</table>

* p < 0.05; **p < 0.01.
† SD, standard deviation; SBP, systolic blood pressure; DBP-4, diastolic blood pressure, fourth Korotkoff phase; DBP-5, diastolic blood pressure, fifth Korotkoff phase.
mass index profiles for JAS- and MYTH-determined Type A and B children during the first and second halves of the study (i.e., months 0–60 and months 68–136). JAS-determined Type B females tended to have higher body mass indices than Type A females when body mass index profiles in both the first and second halves of the study were compared, although these differences were not statistically significant (the main effect \( \chi^2 \) values were 2.8 and 3.4; corresponding \( p \) values were less than 0.10) (see figure 1). MYTH-determined Type B females, however, tended to have significantly lower body mass indices than did Type A females in both measurement periods (the main effect \( \chi^2 \) values were 3.9 and 5.9; corresponding \( p \) values were less than 0.05). Comparisons of the body mass indices of Type A and B males according to the JAS and MYTH did not yield significant results (data not shown). There were no significant differences among males or females with respect to body mass index slopes (i.e., the \( p \) values for Group \( \times \) Time interaction terms were all greater than 0.05).

Because of the associations between body mass index, sex, and method of Type A/B assessment, we conducted sex-specific analyses controlling for body mass index. Thus, for each screening visit, we calculated body mass index-adjusted blood pressure levels using linear regression analysis prior to completion of longitudinal analyses of change in blood pressure by Type A status. This approach attains the same goals as the use of body mass index as a time-dependent covariate in the longitudinal analysis, and has the advantage of making the longitudinal model more efficient, simple, and clear. We also adjusted our \( \alpha \) level for determination of statistical significance to 0.01 for these analyses, since we were using 36 separate longitudinal models for our three Type A measures (JAS, MYTH, and the combination measure), three blood pressure measures (DBP-4, DBP-5, and systolic blood pressure), and two sexes in the first and second halves of the study.

There were significant changes in body mass index-adjusted blood pressure values over time for males and females (i.e., there was a significant time effect). However, neither change in blood pressure nor blood pressure profiles were associated with Type A status as assessed by the JAS or by the combination Type A classification measure (i.e., neither the Type A main effect nor the Type A \( \times \) Time interaction was significant). MYTH-assessed Type B females had significantly different DBP-4 and DBP-5 profiles than did MYTH-assessed Type A females during the second half of the study (the main effect \( \chi^2 \) values were 7.8 and 8.4; corresponding \( p \) values were less than 0.01). Figure 2, which plots mean body mass index-adjusted

**FIGURE 1.** Body mass indices (weight (kg)/height (m²)) of females assessed as having a Type A or Type B behavior pattern by the Matthews Youth Test for Health (MYTH) and the Jenkins Activity Survey (JAS): Minneapolis Children's Blood Pressure Study, 1978–1990.
DBP-4 and DBP-5 levels over the 10-year period, shows that, over time, MYTH-assessed Type B females tended to have higher diastolic blood pressures than did Type A females. There were no significant differences in blood pressure profiles for MYTH-assessed Type A and B males.

**DISCUSSION**

In contrast to some previous research, this study failed to confirm higher blood pressures in Type A participants versus Type B participants. Furthermore, we did not find a larger increase in blood pressure over a 10-year period, when analyzing supine blood pressure for the first 60 months and seated blood pressure for the remaining study period, in Type A versus Type B children. Rather, Type B females and, to a lesser extent, Type B males tended to have higher blood pressures than did their Type A counterparts (see table 3 and figure 2).

These findings conflict with those of two earlier reports which did find an association between Type A status and change in blood pressure (16, 18). The first study found that one factor component of the Type A scale was associated with consistently elevated blood pressures in comparison with those with consistently low blood pressures during the 6-year study period (18). This study used a 17-item measure of Type A behavior comprised of items from the MYTH and the Swedish version of the JAS. Rather than computing an overall Type A score on this measure, these authors reported results from four factor-analytically derived subscales. Mean scores on these subscales were compared in two groups of adolescents who scored one deviation above and one deviation below the group mean for systolic blood pressure \((n = 72)\) and DBP-5 \((n = 44)\) during each of the three blood pressure assessment periods. There were significant differences in the high and low systolic and diastolic blood pressure groups for one of the four factors, labeled "aggression-competitiveness" by the investigators.

In the second study \((n = 375)\), Garrity et al. (16) found that young Type A adults, who were administered the JAS at the conclusion of the study, had significantly greater 7-year increases in systolic and diastolic blood pressure than did those identified as Type B. Systolic blood pressure among Type B individuals actually dropped an average 1.47 mmHg. Because blood pressure was measured only at the beginning and end of the study, it is not possible to determine whether this drop was related to regression toward the mean or reflected an actual decrease in systolic blood pressure over the 7-year study period.

Both of these studies used substantially different methodologies, and therefore their results are not directly comparable to our findings. One critical difference in our study compared with this previous research.

**FIGURE 2.** Body mass index-adjusted fourth- and fifth-Korotkoff phase diastolic blood pressures (DBP-4 and DBP-5) among females assessed as having a Type A or Type B behavior pattern by the Matthews Youth Test for Health: Minneapolis Children's Blood Pressure Study, 1978–1990.
is that the age range of our participants was lower. Perhaps Type A behavior leads to greater increases in blood pressure only in young adults (average age = 28.6 years) such as was reported in the study by Garrity et al. (16).

The present study had several advantages over the previous research. First, we enrolled a large cohort of children in the study; second, participants had their blood pressure assessed on 18 separate occasions approximately twice per year; third, blood pressure was assessed using a detailed protocol; fourth, separate Type A measures were administered in 1982 and again in 1987–1990; fifth, we collected data on an ethnically diverse population; and sixth, we conducted sex-specific analyses that controlled for body mass index.

While this study represents an improvement over previous research, several limitations should also be noted. Questions can be raised concerning study generalizability and the validity of the measures used to assess Type A behavior. Threats to the internal validity of this study were assessed, in part, by examining sociodemographic characteristics and blood pressure among participants who did and did not complete the Type A measures (see table 1). For the comparison of MYTH completion status, the group which did not have a MYTH score comprised students who were not selected to have a MYTH scored by a teacher, while for the JAS the group which did not have a valid score represented participants who were lost to follow-up in 1987–1990. Results for the MYTH comparison revealed that children who did not have a MYTH assessment were older, more likely to have a lower household income, and more likely to have a higher body mass index than were those in the group which did have the MYTH scored. Blood pressures assessed concurrently with MYTH assessment did not differ significantly between the two groups. However, mean systolic blood pressure assessed at the post-high school screening was significantly lower in the group that did not complete the MYTH in 1982 than in the group that did. Mean post-high school diastolic blood pressure was also lower in the former group than in the latter, but these differences were not statistically significant. These findings suggest that differences in mean blood pressure in the two groups became more pronounced in those present for the post-high school screening. The influence of these findings on the interpretation of the present study is unclear. However, the magnitude of differences between these two groups was generally not great; therefore, any bias present is also unlikely to be large.

The validity and psychometric properties of the Type A measures used in the present study may also be considered a study limitation. The MYTH has high internal consistency (e.g., Cronbach's α > 0.90) but only modest interrater reliability (r = 0.55–0.64) (37). The 1-year test-retest reliability of the JAS is also modest (r = 0.60–0.70) (36).

Some investigators also consider the validity of the MYTH and the JAS inadequate. For example, the discriminant validity of the MYTH is questioned on the basis of the significant correlations between this measure and teachers' ratings of hyperactivity (37). Furthermore, the JAS has a low correlation with the Structured Interview (42), which is considered by many to be the "gold standard" by which all other Type A measures should be judged.

Structured Interviews assessing Type A behavior in children have been developed (43, 44). Upon further validation, these measures may also become as widely accepted as the Structured Interview for adults. However, child and adolescent versions of the Structured Interview will always be limited by their higher administrative and scoring costs relative to the costs of paper-and-pencil measures of Type A behavior. These higher costs restrict the use of the structured interview format in large-scale epidemiologic studies and clinical trials.

An alternative approach is to use a combination of measurement strategies such as peer ratings, teacher ratings, and self-report measures (37). We adopted a similar strategy in the present analysis by cross-classifying participants on the basis of scores on the JAS and the MYTH. However, validation of a multimethod assessment approach, such as that used in the present study, was not done.

In summary, findings from this report suggest that among children and adolescents, Type A behavior is not associated with blood pressure, nor does it independently predict change in blood pressure or rate of change in blood pressure among school-aged children.

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