Predictive value and rate of change of blood pressure throughout adolescence: a Belgian prospective study

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Journal of Hypertension 1991, **9** (suppl 6):S266–S267

Keywords: Adolescence, blood pressure, predictive value, rate of change, epidemiology.

Introduction

We performed a prospective study on the natural course of blood pressure throughout adolescence. The major goals were to assess the predictive value of a high blood pressure level at the age of 12 years and the feasibility of developing a screening test for the early detection of young subjects at risk of developing chronic hypertension. By measuring the relationship between the initial level and subsequent changes in blood pressure, we looked for a phenomenon previously demonstrated in adults [1,2].

Subjects and methods

We studied 583 adolescents (399 boys, 184 girls; mean age ±s.d. 12.8 ±1 years) recruited at random from the first grade of secondary schools in the Province of Liège. Data were collected over 4 years with annual examinations in the Medical Center of the schools. Visits were carried out at the same time of the day and during the same month of the year. Blood pressure was measured with a mercury sphygmomanometer (Miniatur 300 K). The adult cuff size was used. Diastolic blood pressure was defined as phase V of Korotkoff sounds. Subjects were in the supine position and at rest for at least 10 min before the blood pressure measurements.

At each visit the blood pressure was recorded four times, by the same observer throughout the study. Skinfold thickness was measured with a Harpenden caliper at four different sites: bicipital, tricipital, subscapular and supra-iliac. Relative weight was assessed by the body mass index. Any positive history of hypertension in either parent, the age of menarche, use of the contraceptive pill and smoking habits (number of cigarettes per day) were recorded by questionnaire.

Of the 583 subjects at entry, 240 were followed up for at least 3 years. Comparisons of mean blood pressure and all other variables collected in the survey (Student's t-test for means adjusted for sex and age) between those who left the study and the remaining sample did not show any significant difference.

The sensitivity and specificity of a screening test for young people at risk of elevated blood pressure by reason of a high initial blood pressure were estimated on a subsample of 103 subjects for whom a complete follow-up was available.

The rate of blood pressure increase was estimated by the coefficient of a linear regression between blood pressure and time. A second linear regression was performed between the rate of blood pressure increase as the dependent variable and the initial blood pressure level as the independent variable of the model, the coefficient of the latter being adjusted according to Blomqvist [3].

Results

Sensitivity and specificity of the screening test

Table 1 shows that the initial values were good predictors of the blood pressure level throughout the study. The specificity was very high when the selection criteria were set to the 75th percentile and increased when the 90th percentile was used. About 60% of subjects with high blood pressure at the end of the follow-up were correctly classified on the basis of blood pressure values at the initial screening, but this sensitivity decreased to 27% for initial levels above the 90th percentile. No difference in specificity or sensitivity was observed in comparing diastolic versus systolic blood pressure in this age group.

Table 1 shows that one adolescent out of every two (56% for the 75th percentile and 50% for the 90th percentile) who had a high initial systolic blood pressure had an elevated blood pressure at the end of adolescence. The predictive value of diastolic blood pressure appeared to be lower than that of systolic blood pres-

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Table 1. Sensitivity and specificity of a screening test for early detection of young subjects at risk for future hypertension (n = 103).

Threshold of high blood pressure	Sensitivity (%)	Specificity (%)	Predictive value (%)
SBP > 75th percentile	60	92	56.2
SBP > 90th percentile	27	96.7	50
DBP > 75th percentile	43.5	81.2	40
DBP > 90th percentile	28.6	88.8	28.6

SBP, systolic blood pressure; DBP, diastolic blood pressure.

sure. According to the influence of growth on blood pressure levels, the predictive value was reviewed using cut-off points corresponding to the 75th or the 90th percentiles of the distribution of blood pressure expressed by height or weight. No significant difference appeared whether the predictive value was calculated according to age (56%), height (53%) or weight (54%).

Rate of change versus initial blood pressure level

To estimate the rate of blood pressure increase, a regression of blood pressure on time was performed. Between the ages of 12 and 17 years, systolic blood pressure increased by 3.4 mmHg/year in boys (2.8 to 3.9 mmHg/year) and 1.4 mmHg/year in girls (0.3 to 2.6 mmHg/year). The corresponding increases in diastolic blood pressure were 1.5 mmHg/year (0.9 to 2.0 mmHg) and less than 1 mmHg/year (−0.1 to 1.4 mmHg/year).

The initial blood pressure effect was estimated by computing a second regression of the individual slopes on estimated initial blood pressure levels. The coefficient of that regression was then adjusted for random errors in the independent variable [3]. Despite that correction, the relationship remained negative (−0.06 mmHg/year per mmHg systolic, −0.04 mmHg/year per mmHg diastolic; Table 2). However, using the standard error of these coefficients, none of the coefficients (either systolic or diastolic) met the 5% level of significance. This suggests that the blood pressure level at 12 years of age does not predict the rate of increase.

Table 2. Adjusted coefficient of regression (for random errors) for the rate of change in blood pressure on the initial level (n = 103).

	n	Adjusted coefficient of regression (mmHg/year per mmHg)	s.e.	*P*
Systolic blood pressure	Males 75	−0.10	0.03	<0.01
	Females 28	+0.04	0.08	NS
Total	103	−0.06	0.07	NS
Diastolic blood pressure	Males 75	−0.05	0.06	NS
	Females 28	+0.14	0.26	NS
Total	103	−0.04	0.04	NS

Discussion

The results of the present study suggest that screening at the age of 12 years is not sufficiently sensitive (27%) to allow a cost-effective mass screening of blood pressure at this age in young people considered at risk of future hypertension.

While the initial blood pressure level appears to predict the position of the subjects in the distribution curve of blood pressure 4 years later, it does not affect the rate of blood pressure change over time, even after correction for the phenomenon of regression to the mean. This conclusion agrees with the data presented by Hofman and Valkenburg [4] from a follow-up study in Dutch adolescents.

References

1. SVARSUDD K, TIBBLIN G: **A longitudinal blood pressure study: change of blood pressure during 10 years in relation to initial values. The study of men born in 1913.** *J Chronic Dis* 1980, 33:627–636.
2. WU M, WARE JH, FEINLEIB M: **On the relation between blood pressure change and initial value.** *J Chronic Dis* 1980, 33:637–644.
3. BLOMQVIST N: **On the relation between change and initial value.** *J Am Statist Assoc* 1977, 72:746–749.
4. HOFMAN A, VALKENBURG HA: **Determinants of change in blood pressure during childhood.** *Am J Epidemiol* 1983, 117:735–743.