A longitudinal study of blood pressure in Spanish schoolchildren

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Abstract

Blood pressure (BP) values and the phenomenon of tracking were evaluated in a group of 481 schoolchildren over a nine year period starting at age 6 years. BP values were obtained yearly by taking the mean of two measurements at one visit, measurements were taken by only two observers during the study. For both systolic and diastolic BP, correlation coefficients between year 9 and previous measurements increased as the year of examination approached year 9, and ranged from 0.79 to 0.81 for systolic BP, and from 0.52 to 0.55 for diastolic BP. For children in the upper quartile of systolic BP at any previous examination, more than 70% remained in the upper quartile at the year 9 examination. More than 90% of children who were not in the upper quartile of systolic BP at any previous examination remained in non-upper quartiles at year 9. This novel longitudinal study of BP in a cohort of Spanish schoolchildren suggests that the degree of tracking of BP during childhood years could be higher than described previously.

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In the past 25 years, there has been an increasing interest in the study of blood pressure (BP) in childhood, either in the definition of normal values or in the phenomenon of "tracking" of BP values from childhood to adulthood.^{1,2} In

spite of the high number of epidemiological studies published,³⁻¹³ many of them have been transverse, with few longitudinal studies having been performed.⁹⁻¹³ Moreover, in general, most longitudinal studies have been on North American or Asian populations, with few studies on European populations. In addition, the phenomenon of tracking has mostly been assessed from childhood to adulthood,^{14,15} with little information about this phenomenon within childhood and adolescence.

We aimed to carry out a longitudinal study of BP in a cohort of 6 year old Spanish children over a nine year period and to assess the degree of tracking during this time.

Subjects and methods

SUBJECTS AND MEASUREMENTS

A cohort of 518 children (261 boys and 220 girls), aged 6 at entry into the study, was assembled in 1982 at a single school in the city of Madrid, Spain, in a working class district. Each year, from 1982 to 1989, and as a part of a medical general examination, BP readings were taken by a standard procedure (see below), with two measurements at each visit. Of the 518 subjects initially enrolled, 37 (20 boys and 17 girls) left the school during the follow up period. At age 6, these 37 children had similar weights, heights, and systolic and diastolic BP values to the cohort.

BP measurements were performed by two trained observers with standard mercury sphygmomanometers. BP was measured in the right arm, with the subject seated and quiet after a five minute rest, the forearm at heart

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Figure 1 Age specific centiles of blood pressure (BP) measurements in boys.

Figure 2 Age specific centiles of blood pressure (BP) measurements in girls.

level, and the stethoscope in the antecubital fossa. Systolic and diastolic BP were recorded as the first and fourth Korotkoff phases, respectively. The mean from the two readings

at each examination was used in data analysis. Height and weight were measured using a standard scale.

DATA ANALYSIS

Pearson correlation coefficients were used to assess the relations of age with BP and to measure the degree of BP tracking over time. For further analysis, the cohort was divided into two groups, separately for systolic and diastolic BP, based on their BP at the year 9 examination (14 years of age): (1) children above the 75th centile (assumed to have relatively high BP values), and (2) the remaining children. Sensitivity, specificity, predictive value positive (PVP), and predictive value negative (PVN) were calculated to evaluate previous BP measurements (less than or greater than 75th centile) as a test to predict BP rank at year 9 examination.

Results

Figures 1 and 2 show BP values. BP values increased with age, with a sharper increase from 10 to 11 years for systolic BP. Systolic and diastolic BP values correlated significantly with age ($r = 0.70$ for systolic BP (0.72 for boys and 0.71 for girls); and $r = 0.51$ for diastolic BP (0.51 for boys and 0.52 for girls); all $p < 0.001$).

For both systolic and diastolic BP values, correlation coefficients between year 9 BP and previous BP measurements increased as the year of examination approached year 9. Correlation coefficients for systolic BP ranged from 0.79 to 0.81 and were considerably higher than for diastolic BP, which ranged from 0.52 to 0.55. When boys and girls were analysed separately, correlation coefficients were very similar in both sexes.

Figure 3 shows the value of previous BP measurements in predicting the year 9 BP group. Only systolic BP values have been considered because diastolic BP values showed a considerably lower degree of tracking. Sensitivity, specificity, PVP, and PVN of previous BP measurements in predicting year 9 BP rank are displayed. All these values tended to increase as the year of evaluation approached year 9. Differences between sexes were small.

Discussion

To date, longitudinal studies of BP in childhood have generally included children with a wide range of ages,¹²⁻¹³ have frequently had a short follow up interval,¹² and have usually failed to perform yearly BP measurements.¹⁰⁻¹³ Therefore, our study is unique because it followed a group of 6 year old children over a 9 year period, during which yearly BP measurements were performed. As a longitudinal study, it confirms the findings of previous transverse epidemiological BP studies; that is, an increase of BP values with age in both sexes.

Blood pressure tracking correlations described in our study were considerably higher than reported previously, particularly for systolic BP.¹²⁻¹⁶⁻¹⁹ It is worth noting that this high degree of tracking has been found despite the fact that BP values were obtained with only two

Figure 3 Sensitivity, specificity, predictive value positive (PVP), and predictive value negative (PVN) of previous blood pressure (BP) measurements (less than or greater than 75th centile) to predict systolic BP rank (less than or greater than 75th centile) at the year 9 examination.

measurements at one visit each year. In fact, many authors have reported that BP serial measurements are essential to improve the BP tracking process.¹⁴⁻¹⁸ Two attributes of the methods used in our study could explain these discrepancies. First, the follow up interval of our study did not completely cross the crucial ages of adolescence, where differential growth and maturation rates occur. Second, all BP measurements were performed by only two observers, which could have minimised inter-observer variability.

More than 70% of children who were in the top quartile for systolic BP at 6 years or later remained in the top quartile at 14 years of age. This high positive predictive value indicates that a single upper quartile reading in children could be useful for identifying adolescents who will be in the top quartile for systolic BP. This finding clearly contrasts with previous studies that described BP measurements in children to be of little value for predicting BP rank at future examinations.¹⁷⁻¹⁹ However, our finding has little clinical relevance, because it gives no information about BP evolution in adulthood, when cardiovascular diseases will develop. In fact, in late adolescence and adulthood certain habits and lifestyles able to influence BP are acquired. Tobacco consumption, use of oral contraceptives, and "adult" exercise, dietary, and working habits could probably modify this "natural" tracking process, and might be responsible for the lower degree of tracking described in previous studies that have evaluated the BP tracking process from childhood to adulthood.¹⁴⁻¹⁵

Predictive negative value—that is, the probability that a child with a BP measurement not in the upper quartile will remain in a non-upper quartile at 14 years of age, was > 90% in all cases. This finding suggests that the tracking process also takes place for children in lower quartiles. In the clinical setting, this finding indicates that a very high proportion of children with a BP measurement in a non-upper quartile will remain in a non-upper quartile in future examinations during childhood.

In conclusion, we have conducted a novel longitudinal study of BP in Spanish children from 6 to 14 years, the results of which suggest

that the degree of tracking of blood pressure during childhood years could be higher than described previously. However, we should point out that our results, limited to the childhood and adolescent period, could not be considered an argument for routine blood pressure screening in children.

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