Blood Pressure Trajectories in Youth and Hypertension Risk in Adulthood: the 1970 British Cohort Study

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Running head: Blood pressure trajectories
During the last ten years, raised blood pressure (BP), including hypertension, has been the leading contributing factor to cardiovascular disease burden globally. Current prevention strategies target adults, but intervention earlier in the lifecourse may be needed to significantly reduce cardiovascular disease risk in adults. The degree to which BP tracks from childhood to adulthood vary by sex, age, and length of study follow-up, suggesting that a single BP measurement may not be enough to identify children who may benefit from early interventions. Sparse data exist on BP trajectories from this earlier period. In one study, a ‘high-increasing’ trajectory was associated with carotid intima-media thickness and left ventricular mass index in adulthood. We hypothesised that repeat BP measurements in childhood will allow identification of BP trajectories that reliably predict adulthood hypertension. Adulthood diabetes was examined as a secondary outcome, as another major risk factor for cardiovascular health.

**Methods**

We used data from the 1970 British Cohort Study of people born in England, Scotland and Wales in a single week of 1970. Cohort members underwent clinical examinations at age 10, 16, and 46 years that included measurement of BP using a mercury sphygmomanometer (childhood) and automated Omron HEM-907 device (adulthood). A total of 5,212 people (2,674 women) had complete data on baseline and adulthood BP, and 2,486 provided data for all three assessments. Close agreement has been shown between the auscultation and oscillometric devices.

High BP in childhood was defined using the 95th centile for systolic and diastolic BP relative to sex and height at age 10. Hypertension at age 46 was defined as systolic/diastolic BP≥140/90mmHg taken from the average of the second and third readings after 5 minutes seated rest, and/or prescribed anti-hypertensive medication (confirmed from British National Formulary codes on medication dispensers). For analyses using the continuous BP data, a constant of 10mmHg was added to systolic
and diastolic BP in participants taking anti-hypertensive medication. A diabetes outcome in adulthood was generated from data on physician diagnosed diabetes and/or glycated haemoglobin ≥ 48mmol/mol (>6.5%).

We generated four BP trajectories using baseline systolic BP at age 10 and the change in BP between ages 10 to 16: ‘Stable low’ was defined as systolic BP below the median (100 mmHg) at baseline and below the median (13 mmHg) for increase in systolic BP between age 10 and 16 years old; ‘low + increase’ was baseline BP <100mmHg and an increase ≥ 13mmHg; ‘Stable high’ was baseline SBP ≥ 100mmHg and change < 13 mmHg; ‘high + increase’ was baseline SBP ≥ 100mmHg and change ≥ 13 mmHg.

The association of BP trajectory with hypertension and diabetes outcomes at age 46 was examined using logistic regression models where the relationship was adjusted for sex, body mass index, sports participation aged 10 years, father’s occupation, parental smoking. All analyses were conducted using SPSS version 22.

**Results**

At the age 46 follow-up, 702 cases of hypertension and 202 cases of diabetes were recorded. High BP (based on 95% centiles) was evident in 1.9% of the cohort at age 10 and, compared with normal BP, was associated with around a doubling of hypertension risk at age 46 (odds ratio= 2.48; 95% CI, 1.60, 3.88) (Table 1), although not with diabetes (odds ratio=1.24; 0.53, 2.92). Between the assessments at age 10 and 16 years there was, on average, an increase in both systolic (98.1 vs. 111.1 mmHg, p<0.001) and diastolic BP (62.4 vs. 69.3 mmHg, p<0.001). Participants who had elevated systolic BP at age 10 and continued to rise above average levels through to age 16 demonstrated over a 2.6-fold increased odds of hypertension by middle-age (Table 1) although no associations were observed for diabetes (odds ratio =1.64; 0.71, 3.76). Compared to cohort members classified as ‘stable-low’ trajectory,
systolic BP at age 46 was elevated by 3.3 (95% CI, 1.4 – 5.2) mmHg in the ‘low + increase’, 5.2 (3.3 – 7.0) mmHg in ‘stable high’, 8.4 (6.2 – 10.7) mmHg in the ‘high + increase’ after adjusting for covariates. Differences in diastolic BP followed a similar pattern; 2.6 (1.1 – 4.0) mmHg in the ‘low + increase’, 3.4 mmHg (2.0 – 4.8) mmHg in ‘stable high’, 5.8 (4.1 – 7.5) mmHg in the ‘high + increase’.

**Discussion**

In the current study, we show that BP in childhood is an important predictor of hypertension risk in middle aged adulthood. Thus, childhood may be a key period for early intervention. The trajectory in BP from 10 to 16 years old was further able to discriminate differences in hypertension risk at age 46/middle age. Although annual BP measurement after 3 years of age is supported by some, such as American Academy of Paediatrics, others have not endorsed such recommendations. Our findings support recommendations to track BP trajectories in clinical settings.
References


Table 1. Crude risk per 1000 person-years and adjusted odds ratio (95% confidence interval) for the association between baseline blood pressure, the trajectory from age 10 to 16 years and risk of hypertension aged 46 years. Sample sizes vary; n= 5,212 had data for age 10/46; n=2,486 had data for ages 10/16/46.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total N</th>
<th>Hypertension cases</th>
<th>Risk per 1,000 person years</th>
<th>Odds ratio† (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BP at age 10 years</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>5112</td>
<td>672</td>
<td>4.2</td>
<td>1.0 (Ref)</td>
</tr>
<tr>
<td>High</td>
<td>100</td>
<td>30</td>
<td>11.9</td>
<td>2.48 (1.60, 3.88)</td>
</tr>
<tr>
<td><strong>BP trajectory between the ages of 10 and 16 yrs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stable low</td>
<td>346</td>
<td>28</td>
<td>2.4</td>
<td>1.0 (Ref)</td>
</tr>
<tr>
<td>Low and increasing</td>
<td>890</td>
<td>111</td>
<td>4.0</td>
<td>1.47 (0.95, 2.29)</td>
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<tr>
<td>Stable high</td>
<td>904</td>
<td>132</td>
<td>4.7</td>
<td>1.73 (1.12, 2.66)</td>
</tr>
<tr>
<td>High and increasing</td>
<td>346</td>
<td>77</td>
<td>8.0</td>
<td>2.61 (1.63, 4.20)</td>
</tr>
</tbody>
</table>

†Odds ratio adjusted for sex, body mass index, sports participation aged 10 years, father’s occupation, parental smoking.