

## How to Correctly Evaluate Blood Pressure Values in Children? Strengths, Limitations and Gaps of Current Pediatric Blood Pressure Nomograms: a Critical Review.

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**Background:** despite blood pressure (BP) is an essential parameter at all the age and in any clinical setting, various limitations still persists in current pediatric nomograms for BP., *Aim:* to review the strength/limitation of current pediatric BP nomograms.

**Methods:** A literature search was performed in June 2013 within the National Library of Medicine using the keywords *BP, pediatric, reference values/nomograms*. The search was further refined by adding the keywords *neonates/infants/adolescents, range/intervals*. Analysis of sample size and its characteristic (age distribution, morphometric details, racial differences) was previously performed. Secondly we evaluated methodological/statistical issues: how BP was measured, how data have been normalized, how they have been expressed, whether a correct analysis was applied and whether potential counfounders/source of errors have been investigated.

**Results:** 66 studies were selected for final analysis. The analysis highlighted the accuracy of latest studies but also underscored that some limitations still remain. In many studies the number of healthy subjects was limited, particularly for some age groups (i.e. neonates/infants), some geographic area and ethnic groups. The methodologies utilized for the performance and normalization of measurements were heterogeneous as well as the expression of the normalized data (percentiles/mean values). Although most studies adjusted measurements for age and/or height, classification of age and/or height subgroups varied, and the relationships of the measurements to other morphometric parameters (i.e. body size and heart rate) were not always addressed. Gender differences were generally but not universally accounted while other confounders such as ethnicity, hereditary, seasonal and socio-economical variations were seldom evaluated.

Hence, while for older children reference intervals were substantially reproducible, in neonates and infants greatly varied. Data on ambulatory BP and response to stress test furthermore are extremely limited and criteria of stress test interruption even absent.

**Conclusions:** Valid BP pediatric nomograms have been recently become available. However a comprehensive nomogram, which involves a large population of healthy children, uses standardized methodology, and fully evaluate the influence of various confounders is still lacking thus affecting the accuracy in the evaluation of BP in children, especially in neonates.

**Table-1:** Major pediatric BP nomograms divided according to geographic area. G=gender, M=males

| Author                | Sample size | Age Interval | Weight; BMI                          | G (M) |
|-----------------------|-------------|--------------|--------------------------------------|-------|
| <b>America</b>        |             |              |                                      |       |
| Nichols 2006 Tobago   | 3749        | 12-18 yrs    | M/F BMI 20.6 (4.2), 21.8 (5)         | 1610  |
| Paradis 2004 Canada   | 3589        | 9-16 yrs     | nr                                   |       |
| Rosner 2007 USA       | 49967       | 1-17 yrs     | nr                                   | 25651 |
| Fourth Rep. 2004 USA  | 63227       | 1-17 yrs     | nr                                   | 3352  |
| <b>Australia</b>      |             |              |                                      |       |
| Blake 2000 Australia  | 2876        | 1-6 yrs      | BMI 17.0 (1.4) 16.2 (1.3) 15.8 (1.8) | 546   |
| Roy 1984 Australia    | 9851        | 5-13 yrs     | 18-53 kg                             | 4884  |
| <b>Europe</b>         |             |              |                                      |       |
| De Man 2004 France    | 28043       | 4-19 yrs     | nr                                   | nr    |
| Menghetti 1999 Italy  | 11519       | 5-17 years   | nr                                   | 6258  |
| Sanchez Spain1992     | 34986       | 1-18 years   | nr                                   |       |
| Tumer 1999Turkish     | 5599        | 0-18 y.o.    | nr                                   | 2835  |
| <b>Asia/Mead East</b> |             |              |                                      |       |
| Merhi 2009 Beirut     | 5710        | 5-15 yrs     | nr                                   | 2918  |
| Chadha 1999 India     | 8293        | 5-14 yrs     | Every year                           | 4623  |
| Kelishadi 2006 Iran   | 21111       | 6-18 yrs     | BMI 18.53±3.84                       | 10253 |
| Okamura 1981 Japan    | 17422       | 7-18 yrs     | nr                                   | 1174  |