SCHÓLARENA

RESEARCH ARTICLE

# Prevalence and Associated Factors of Elevated Blood Pressure in Adolescents in Schools in Lubumbashi, Democratic Republic of Congo

Kakoma PK[1], Muyumba EK[1], Mukeng CK[2], Musung JM[1], Banze JP[1], Kakisingi CN[1], Nkulu DN[1] and Mukuku O[3*]

[1]*Département de Médecine Interne, Université de Lubumbashi, République Démocratique du Congo*
[2]*Département de Santé Publique, Université de Lubumbashi, République Démocratique du Congo*
[3]*Institut Supérieur des Techniques Médicales de Lubumbashi, République Démocratique du Congo*

[*]**Corresponding author:** Mukuku O, Institut Supérieur des Techniques Médicales de Lubumbashi, République Démocratique du Congo, Tel: +243997925649, E-mail: oliviermukuku@yahoo.fr

## Abstract

**Introduction:** Hypertension is a major public health problem worldwide due to its high prevalence and its association with cardiovascular diseases with an increased risk of morbidity and mortality cardiovascular. Elevated Blood Pressure (EBP) in adolescence progresses to hypertension in adulthood.

**Objective:** To determine the prevalence of EBP and identify associated factors in adolescents in the school community in Lubumbashi.

**Methods:** This is a cross-sectional analytical study, using a random sample of adolescents aged 15 to 19 years old, enrolled in secondary schools in Lubumbashi in the Democratic Republic of Congo. Each student was subject to three measures of blood pressure (BP). The prevalence of EBP was determined according to the new standards internationally. The different associations between EBP with sex, birth weight, status weight, waist circumference and heart rate were evaluated.

**Results:** 1,766 adolescents participated in the study. The overall prevalence of EBP was 30.6%. Associated factors with EBP were overweight (p<0.0001), obesity [boys (p = 0.049), gender female (p<0.0001)], waist circumference (p<0.0001) and heart rate (p = 0.034). In log-binomial regression, only the waist circumference (p<0.0001) and heart rate (p = 0.014) were the factors associated with the occurrence of EBP.

**Conclusion:** Lubumbashi school's adolescents have an abnormally EBP. This notion challenges public health policy makers to put in place prevention and fight against hypertension since childhood.

**Keywords:** Elevated Blood Pressure; Associated Factors; Adolescent; School Environment; Lubumbashi; DRC

**List of abreviations:** 95% CI: 95% Confidence Interval; BMI: Body Mass Index; BP: Blood Pressure; DBP: Diastolic Blood Pressure; DRC: Democratic Republic of Congo; EBP: Elevated Blood Pressure; HR: Heart Rate; SBP: Systolic Blood Pressure; SD: Standard Deviation; WC: Waist circumference

## Introduction

Elevated Blood Pressure (EBP) during teenage age envolves to hypertension when adult. This phenomenon is called 'blood pressure (BP) tracking' [1]: 48% of adults with hypertension had a HBP during their childhood [2]. The prevalence of EBP in children and adolescents and their associated factors has already been documented in some countries in the world. Especially in the USA (11%) [3], in Canada (0.8%) [4], in Chine (1.44% - 9.54) [5], in Tunisia (35.1%) [6], in Algeria (13%) [7], and in the Seychelles (7.5%) [8]. Overweight, obesity, physical inactivity, excess sodium intake, low birth weight, waist circumference, and increased heart rate were identified as factors associated with EBP. Hypertension continues to kill millions of people every year, and its rates in adolescent and children is increasing drastically [9,10].

There is very little information on the prevalence of EBP and its associated factors among adolescents aged 15 to 19 in Lubumbashi, an environment where the prevalence of hypertension in adults appears to be high.

The objective of our study was to investigate the prevalence and predictors of EBP among adolescent aged 15 to 19 years in the school in Lubumbashi in Democratic Republic of Congo.

## Methodology

### Study design, population and period

This is a cross-sectional study carried out in a population made up of adolescents aged 15 to 19, regularly enrolled in targeted schools in Lubumbashi (capital of the Haut-Katanga Province and second largest city in the Democratic Republic of Congo) whose parent or guardian has freely read and signed the informed consent during the following school years: 2013 – 2014, 2014 – 2015, and 2015 – 2016.

Our sample consisted of 1,766 adolescents who were randomly recruited according to a two-level cluster stratified sampling plan. Thus, a sample of schools (distributed by municipality) were successively selected, then a sample of classes in each selected school, and finally all the students (statistical units) enrolled within the selected classes were retained as adhering to the investigation. The data were collected by the trained medical study team who received refresher training at the start of each data collection phase.

We included in this study:
- Any subject aged 15 to 19 and regularly enrolled in a primary or secondary school in the city of Lubumbashi;
- Have a birth weight declared by one of the parents or the legal guardian of the pupil who has consented to undergo the examination without constraint;
- Parent / guardian having signed the free and informed written consent, according to the Declaration of Helsinki and its amendments before participating in the study.

We have excluded:
- Any subject who does not meet the conditions of schooling or age;
- Any student or parent who has expressed a refusal to take the exam;
- Any subject carrying a chronic disease which influences blood pressure (nephropathy, diabetes mellitus, personal history of hypertension);
- Any subject taking a drug treatment which can influence blood pressure including anti-hypertensives, anti-arrhythmics, psychostimulants, corticosteroid therapy, and thyroidhormones.

### Study variables

The variables in our study were: age, sex, systolic blood pressure (SBP), diastolic blood pressure (DBP), weight, height, body mass index (BMI), waist circumference (WC), frequency heart rate (HR) and birth weight.

BP and heart rate (HR) were measured using a Datascope Accutorr Plus brand automatic oscillometric blood pressure monitor (Datascope Corporation, USA). SBP and DBP measurements were calculated as the average of the last two of the three measurements, and were considered for analysis. This device gave at the same time the BP and the HR. Appropriately sized, Critikon brand cuffs (GE Healthcare, USA) were also used, depending on the width of the arm (at least 40% of the arm circumference) and its length (12 x 19 cm, 17 x 25cm, 23 x 33cm, to cover 80-100% of the subject's arm circumference). The cuff size was determined by measuring the circumference at mid-height of the arm. BP and HR were measured at least 30 minutes after physical exercise or the last meal, in a subject at rest 5 minutes before taking [1,8,11]. Subject was in a seated position with arm and back supported, cuff at heart level, feet resting on the floor, and legs uncrossed. The cuff was applied to the right arm, then wrapped to a seal that did not allow two fingers to be inserted under it. The lower edge of the cuff was placed 2 cm from the ulnar dimple. Each student was given three BP and HR measurements, one minute apart, on the same day [12]. The weight (expressed in kg recorded to the nearest 0.1 kg) was measured twice, in a lightly dressed subject, barefooted, standing on a digital medical scale of the SECA brand (SECA 881 U, Germany). The height (recorded to the nearest 0.1 centimeter) was measured twice with a vertical measuring board, in a barefoot subject, standing, with the shoulders and hips perpendicular to the central axis, the heels against the step, knees together, arms relaxed at your sides and head straight (head looking forward so that the lower edge of the eye sockets is in the same horizontal plane as the external auditory canal). Waist circumference, according to the protocol of the American Academy of Pediatrics [2] and the European Childhood Obesity Group [8], was measured twice, using a non-stretch measuring tape, directly on the skin, at the level of the iliac ridges, at the moment of expiration, in a standing subject, relaxed, not tucking his belly.

BMI was calculated from the formula: BMI = weight (in kilograms) divided by height (in meters) squared and expressed in kg / m².

In developing countries such as ours, given the insufficient declaration of births in the civil registry, we have resorted to birth weights declared by parents or guardians, a strategy adopted by UNICEF and WHO in 2004 for estimating low birth weight in developing countries [13].

### Definition of elvated blood pressure

Taking into account the recommendations of the fourth report of the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents [2,8]. Thus, in our series, the definition of EBP is based on the recommendations of the 2017-Guideline for the Prevention, Detection, Evaluation, and management of higth Blood Pressure in Adults, i.e. SBP values ranging from 120 to 129 mmHg and those of DBP less than 80 mmHg (120-129/<80 mmHg) [14].

## Statistical analyzes

Data were entered using Epi Info software version 3.5.1. And analyzed using SPSS 21.0 software. The dependent variable was BP divided into EBP and normal BP. The independent variables were age, sex, birth weight, waist circumference, BMI and HR.

Qualitative variables were represented as frequency and percentage, while quantitative variables as mean with standard deviation. For ease of calculation, age was decimated using the Ireton formula [15].

Spearman's rank correlation coefficient was used to investigate the association between EBP and independent variables. Student's t-test comparing means of age, sex, height, HR, waist circumference, BMI, birth weight, SBP and DBP was used then the Pearson's chi-square test to assess the association between qualitative variables. The $p$-value $<0.05$ was considered statistically significant with its 95% confidence interval (95% CI).

The Fischer test was used if any of the numerical values were less than 5. To estimate the measure of the strength of association of EBP with other factors, in our cross-sectional study, the prevalence ratio (PR) and its 95% confidence interval (95% CI) were used.

The log-binomial model was used to estimate the risk or probability of having EBP (SBP and / or DBP from the 90th percentile or SBP 120 mmHg and DBP less than 80 mmHg) knowing the other factors.

## Ethical considerations

Written informed consent was obtained from the parent or guardian of the adolescent being surveyed. The approval for the conduct of the study and the related authorizations were obtained from the Medical Ethics Committee of UNILU (UNILU/ CEM/ 027/ 2013 of 09/27/2013), the Provincial Ministry of Education of Haut-Katanga Province and directors of the schools selected.

## Results

The data was collected in 21 secondary schools in the city of Lubumbashi and took place in 3 stages according to the school calendar: from March 17 to May 22, 2014; from October 3, 2014 to May 21, 2015; and from September 30 to December 11, 2015. Of the 8,371 participants who took part in the study, 1,766 were aged between 15 and 19, or 21% of the total, and thus constituting the population on which the analyzes were carried out.

## General characteristics of participants

Among the 1,766 participants surveyed, 1,289 or 73.0% were aged 15 to 17; 995 (56.3%) were female; those with low birth weight numbered 116 (7.0%) (Table 1).

| Variable | Number (n=1766) | Percentage |
|---|---|---|
| **Age group** | | |
| 15-17 years | 1289 | 73.0 |
| 18-19 years | 477 | 27.0 |
| **Sex** | | |
| Boys | 771 | 43.7 |
| Girls | 995 | 56.3 |
| **Birth weight** | | |
| < 2500 grams | 116 | 6.6 |
| ≥ 2500 grams | 1650 | 93.4 |
| **Body mass index** | | |
| Normal | 1693 | 95.9 |
| Overweight | 61 | 3.4 |
| Obesity | 12 | 0.7 |

**Table 1:** Distribution of subjects by age group, sex, birth weight and body mass index

Boys had higher birth weight (p=0.012), higher weight (p<0.0001) and higher height (p<0.0001) than girls. In contrast, the BMI was greater in girls than in boys (p<0.0001). The mean SBP of boys was higher than that of girls (p<0.0001) while HR was more accelerated in girls than in boys (p<0.0001) (Table 2).

| Variable | Boys Mean (SD) | Girls Mean (SD) | p-value |
|---|---|---|---|
| BW (grams) | 3296.4 (674.2) | 3214.3 (580.8) | 0.012 |
| Weight (kg) | 55.6 (8) | 53.5 (7.7) | <0.0001 |
| Height (cm) | 166 (9.3) | 159.1 (8.1) | <0.0001 |
| Waist circumference (cm) | 70.9 (5) | 71.1 (6.2) | 0.2300 |
| BMI (kg/m²) | 20.6 (2.3) | 21.2 (3.2) | <0.0001 |
| SBP (mmHg) | 118.5(11.3) | 116.1 (10.3) | <0.0001 |
| DBP (mmHg) | 68.3(8.2) | 68.6 (7.8) | 0.211 |
| HR (beats per minute) | 74(12.3) | 83.1 (11.8) | <0.0001 |

SD: standard deviation; BW: birth weight; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate.
**Table 2:** Distribution of means of BW, SBP, DBP and HR by sex

## Prevalence of EBP and identification of associated factors

The prevalence of EBP was 30.6% (n = 541) divided into 36.6% (n = 282) among boys and 26.0% (n = 259) among girls (p<0.0001) and was associated with male sex (PR= 1.41; 95% CI: 1.22-1.62).

Regarding birth weight, stratification by sex revealed a significant weak association between birth weight and high BP in boys; while in girls there was no significant difference. (Table 3). Regarding waist circumference, the highest values were found in participants with EBP in both sexes with statistically significant differences. Furthermore, our results revealed that the HRs of participants with EBP were higher than those with normal BP (Table 4).

| Variable | EBP | PR | [95% CI] | p-value |
|---|---|---|---|---|
| Boys | | | | |
| BW | (n=282) | | | |
| <2500 grams | 23 (24.0%) | 0.62 | 0.43-0.90 | 0.006 |
| ≥2500 grams | 259 (38.4%) | Reference | | |
| BMI | | | | |
| Normal | 263 (34.1%) | Reference | | |
| Overweight | 16 (100%) | 2.84 | 2.56-3.13 | <0.0001 |
| Obesity | 3 (100%) | 2.75 | 2.51-3.02 | <0.0001 |
| Girls | (n=259) | | | |
| BW | | | | |
| <2500 grams | 28 (20.3%) | 0.75 | 0.53-1.07 | 0.098 |
| ≥2500 grams | 231 (27.0%) | Reference | | |
| BMI | | | | |
| Normal | 205 (20.6%) | Reference | | |
| Overweight | 45 (100%) | 4.44 | 3.95-5.00 | <0.0001 |
| Obesity | 9 (100%) | 3.94 | 3.54-4.39 | <0.0001 |

SD: standard deviation; BW: birth weight; BMI: body mass index; EBP: elevated blood pressure; PR: prevalence ratio.
**Table 3:** Correlation between BW, BMI and EBP by sex

| Variables | EBP | NBP | p-value |
|---|---|---|---|
| Boys | | | |
| WC (mean±SD) | 71.7 ± 4.4 | 70.5(5.3) | 0.001 |
| HR (mean±SD) | 74.0 ± 13.2 | 73.9(11.8) | 0.896 |
| Girls | | | |
| WC (mean±SD) | 72.0 ± 6.4 | 70.9(6.2) | 0.896 |
| HR (mean±SD) | 86.8 ± 12.1 | 81.8(11.4) | <0.0001 |

SD: standard deviation; EBP: elevated blood pressure; NBP: normal blood pressure; HR: heart rate; WC: Waist circumference.
**Table 4:** Correlation between WC, HR and EBP by sex

In log-binomial regression, waist circumference and HR emerged as factors associated with EBP. Thus, an increase of one centimeter in the waist circumference confers a risk of 1.03 the risk of increasing the BP while the increase of one beat per minute of the HR risks increasing the BP by 1.01 mmHg in both boys and girls.

## Discussion

Among adolescents aged 15 to 19 in school, the present survey shows that the mean SBP for boys was significantly higher than that for girls (p<0.0001), while the DBP was not different in both sexes (p = 0.211). A survey conducted in Tunisia among subjects aged 15 to 19 found that the means of SBP (p<0.0001) and DBP (p<0.001) were higher in girls than in boys [6]. This association found in the present study between SBP and the male sex could be explained by the hormonal changes linked to puberty. Referring to the literature, it is shown that BP increases with increasing age following the increase in muscle mass during puberty in boys [16-18]. In their study including 1,569 subjects aged 13 to 19, Harrabi *et al.* [18] found that 16-, 17- and 18-year-old boys had high SBP with no statistically significant differences, but statistically significant differences were noted in 13- and 14-year-old girls regarding DBP. In their study in children, Forrester *et al.* [19] reported a positive correlation between SBP and age in boys and a negative correlation in girls.

Referring to the 2017-Guideline for the Prevention, Detection, Evaluation, and management of High Blood Pressure in Adults [14], the prevalence of EBP among adolescents aged 15 to 19 was 30.6% (36.6% for boys and 26.0% for girls) in our survey. Prevalences of 10 to 40% have been reported by some authors [6,20-23]. Other authors, on the other hand, have found lower prevalence rates compared to ours ranging from 0.4 to 9.54% [4,5,8]. Comparison of the prevalence of EBP with data from the literature is difficult because of the differences related to the chosen age group of the population, the definition used for EBP, to the BP tables to which we refer to identify the proportion of subjects with EBP and to the method used to measure BP (auscultatory or oscillometric method). This is among the reasons why the prevalence of EBP remains largely underestimated in many countries [22,24].

Conducted in a population aged 15 to 19, our study found an EBP prevalence of 30.6% with the new standards and that it was 17.7% for the old standards. In the same age group in Tunisia, Aounallah-Skhiri *et al.* [6] reported an EBP prevalence of 31.1% according to the standards of The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents [2] considered to be old. In a cohort of 14,187 subjects aged 3 to 18 regularly followed in a large academic urban medical system in northern Ohio (USA), Hansen *et al.* [3] identified 11% who had EBP recorded in their electronic medical records. In Canada, in a series of 2,079 participants aged 6 to 19, 0.8% (95% CI: 0.4 - 1.4%) of them had EBP [4]. Although we have used the new standards, our prevalence of EBP remains lower than that found in Tunisia under the old standards for the same age group concerned. This could be explained by the fact that the rate of overweight (19.3%) and obesity (5%) was high among Tunisian adolescents [6] and that these factors have an impact on BP [21,24].

Taking gender into account, we found that boys had a significantly higher proportion of EBP than girls (36.6% vs. 26.0%; p<0.0001). This finding has also been reported by other authors. By way of illustration, in Tunisia among adolescents aged 15 to 19, the prevalence of EBP was 46.1% in boys and 33.3% in girls (p<0.0001) [6].

No positive relationship was found between blood pressure (SBP and DBP) and birth weight in our series. This could be due to the inaccessibility of birth registration certificates in our country as in several developing countries [25]. Our study used birth weights declared by parents or guardians, which could influence the results. Unlike our study, some studies found low birth weight to be a factor influencing BP [26,27]. In the literature, there appears to be an inverse association between birth weight and BP at different ages late in life. The most telling example is the association between low birth weight and EBP in childhood and the onset of cardiovascular disease in adulthood [28,29].

The present study reports that SBP was significantly associated with BMI, waist circumference and heart rate in both sexes. These results are similar to those of the study by Harrabi *et al.* [18]. The effect of height and weight on BP has already been demonstrated in several previous studies on children concluding in a strong positive association [19,24]. BMI is considered a valid proxy measure of adiposity in children and adolescents [1]. It is an important predictor of EBP [30]. Several studies had noted that overweight and / or obesity are associated with EBP [8,31]. In their study, which involved 1,100 Algerian adolescents aged 12 to 18, Benmohammed *et al.* [7] found a strong association between overweight, obesity and EBP. The results of our investigation corroborate with the previous observations, because the overweight and obese subjects had presented an EBP.

## Conclusion

Elevated Blood Pressure (EBP) is a major cause of disability and death worldwide. EBP at a young age is a risk factor for hypertension in adulthood. The present study reports an EBP prevalence of 30.6% and shows that boys had higher mean SBP than girls. EBP was correlated with overweight and obesity, waist circumference and heart rate. EBP is alarming health risk issues that affect younger populations in developing countries and increasing mortality and morbidity at an early age. Therefore, it is essential to establish an effective healthcare strategy at a young age for the primary prevention of future complications.

## References

1. Chen X, Wang Y (2008) Tracking of blood pressure from childhood to adulthood: a systematic review and meta-regression analysis. Circulation 117: 3171-80.

2. American Academy of Pediatrics (2004) National high blood pressure education program working group on high blood pressure in children and adolescents. Pediatrics 114: iv.

3. Hansen ML, Gunn PW, Kaelber DC (2007) Underdiagnosis of hypertension in children and adolescents. JAMA 298: 874-9.

4. Paradis G, Tremblay MS, Janssen I, Chiolero A, Bushnik T (2010) Tension artérielle des enfants et des adolescents au Canada. Rapports sur la santé 21: 17.

5. Leung LC, Sung RY, So HK, Wong SN, Lee KW, et al. (2011) Prevalence and risk factors for hypertension in Hong Kong Chinese adolescents: waist circumference predicts hypertension, exercise decreases risk. Archives of disease in childhood 96: 804-9.

6. Aounallah-Skhiri H, El Ati J, Traissac P, Romdhane HB, Eymard-Duvernay S, et al. (2012) Blood pressure and associated factors in a North African adolescent population. a national cross-sectional study in Tunisia. BMC Public Health 12: 98.

7. Benmohammed K, Valensi P, Nguyen MT, Benmohammed F, Benlatreche M, et al. (2018) Influence of waist circumference on blood pressure status in non-obese adolescents. International Journal of Adolescent Medicine and Health 20170127.

8. Rolland-Cachera MF (2011) for The European Childhood Obesity Group. Childhood obesity: current definitions and recommendations for their use. International Journal of Pediatric Obesity 2011; 6(5-6): 325–31.

9. Chia YC, Ching SM, Devaraj NK, Chew BN, Ooi PB, et al. (2020) May Measurement Month 2018: an analysis of blood pressure screening results from Malaysia. European Heart Journal Supplements 22: H83-5.

10. Ching S, Chia YC, Chew BN, Soo MJ, Lim HM, et al. (2019) Knowledge on the action to be taken and recognition of symptoms of stroke in a community: findings from the May Measurement Month 2017 blood pressure screening Programme in Malaysia. BMC public health 19: 1602.

11. Rosner B, Cook N, Portman R, Daniels S, Falkner B (2008) Determination of blood pressure percentiles in normal-weight children: some methodological issues. American journal of epidemiology 167: 653-66.

12. Muyumba EK, Nkulu DN, Mukeng CK, Musung JM, Kakoma PK, et al. (2018) Oscillometric blood pressure by age and height for non overweight children and adolescents in Lubumbashi, Democratic Republic of Congo. BMC cardiovascular disorders 18: 9.

13. Bao W, Threefoot SA, Srinivasan SR, Berenson GS (1995) Essential hypertension predicted by tracking of elevated blood pressure from childhood to adulthood: the Bogalusa Heart Study. American journal of hypertension  8: 657-65.

14. Whelton PK, Carey RM, Aronow WS, Casey Jr DE, Collins KJ, et al. (2017) Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Ame College Cardio 71: 1269-324.

15. Ireton MJ (2006) Le capital biologique humain: une expérience Colombienne, relations entre les variables biométriques, écogéographiques, socio-économiques et nutritionnelles d'enfants et d'adolescents scolarisés d'El Yopal, Casanare, Colombie, 2000-2002. Fundacion Auxologica TEA, Bogota-Colombie.

16. Park MK, Menard SW, Yuan C (2001) Comparison of auscultatory and oscillometric blood pressures. Archives of pediatrics & adolescent medicine 155: 50-3.

17. Amah G, Lévy BI (2007) Particularités de l'hypertension artérielle du sujet noir-africain. Sang thrombose vaisseaux 19: 519-25.

18. Harrabi I, Belarbia A, Gaha R, Essoussi AS, Ghannem H (2006) Epidemiology of hypertension among a population of school children in Sousse, Tunisia. Canadian J cardio 22: 212-6.

19. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. Pediatrics 103: 1175-82.

20. Falkner B (2010) Hypertension in children and adolescents: epidemiology and natural history. Pediatric nephrology 25: 1219-24.

21. Aglony M, Acevedo M, Ambrosio G (2009) Hypertension in adolescents. Expert Review of Cardiovascular Therapy 7: 1595-603.

22. Drukteinis JS, Roman MJ, Fabsitz RR, Lee ET, Best LG, et al. (2007) Cardiac and systemic hemodynamic characteristics of hypertension and prehypertension in adolescents and young adults: the Strong Heart Study. Circulation 115: 221-7.

23. Mu M, Wang SF, Sheng J, Zhao Y, Li HZ, (2012) Birth weight and subsequent blood pressure: a meta-analysis. Archives of cardiovascular diseases 105: 99-113.

24. Bradhury J (2002) Early weight gain patterns may affect adult blood pressure. The Lancet 359: 501.

25. Frankel S, Elwood P, Smith GD, Sweetnam P, Yarnell J (1996) body-mass index in middle age, and incident coronary heart disease. The Lancet 348: 1478-80.

26. Steinthorsdottir SD, Eliasdottir SB, Indridason OS, Agustsdottir IM, Palsson R, Edvardsson VO. Prevalence of hypertension in 9-to 10-year-old Icelandic school children. The Journal of Clinical Hypertension 13: 774-9.

27. Yan W, Liu F, Li X, Wu L, Zhang Y, et al. (2013) Blood pressure percentiles by age and height for non-overweight Chinese children and adolescents: analysis of the China Health and Nutrition Surveys 1991–2009. BMC pediatrics 13: 195.

28. Hardy R, Kuh D, Whincup PH, Wadsworth ME (2006) Age at puberty and adult blood pressure and body size in a British birth cohort study. J hypertension 24: 59-66.

29. Edvardsson VO, Steinthorsdottir SD, Eliasdottir SB, Indridason OS, Palsson R (2012) Birth weight and childhood blood pressure. Current hypertension rep 14: 596-602.

30. Toledo E, Beunza JJ, Nunez-Cordoba JM, Bes-Rastrollo M, Basterra-Gortari FJ, et al. (2009) Metabolic risk factors in a cohort of young adults and their association with a body-mass index between 22 and 25 kg/m2. Medicina clinica 132: 654-60.

31. Berenson GS, Srinivasan SR, Bao W, Newman WP, Tracy RE, et al. (1998) Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. New England J med 338: 1650-6.