International Journal of Preventive Medicine

Original Article Open Access

Low Birth Weight as a Predictor of Cardiovascular Risk Factors in Childhood and Adolescence? The PEP Family Heart Study

Gerda-Maria Haas[1], Evelyn Liepold[1], Peter Schwandt[1, 2]

[1]Arteriosklerose-Praeventions-Institut München, Nürnberg, Germany, [2]Ludwig Maximilians University München, Germany

Correspondence to:
Gerda-Maria Haas, Arteriosklerose-Praeventions-Institut, Wilbrechtstr.95, D-81477 München. E-mail: api.schwandt.haas@t-online.de

How to cite this article: Haas GM, Liepold E, Schwandt P. Low birth weight as a predictor of cardiovascular risk factors in childhood and adolescence? The pep family heart study. Int J Prev Med 2015;6:121.

ABSTRACT

Background: Low birth weight is considered a risk factor for cardiovascular disease (CVD) in later life. Because data in children and adolescents are sparse and controversial, we assessed the association of birth weight with CVD risk factors in German youths.

Methods: We categorized 843 urban children and adolescents aged 3-18 years by quintiles of birth weight and measured nine traditional risk factors in terms of body mass index (BMI), waist circumference (WC), systolic (SBP) and diastolic (DBP) blood pressure, total cholesterol (TC), LDL-C, HDL-C, Non HDL-C and triglycerides (TG). SPSS 21 was used for statistical analysis.

Results: Mean values and prevalence of nine anthropometric and lipid risk variables were equally distributed over the five birth weight groups. Though risk factors clustered between 3.0 kg and 4.0 kg of birth weight in both genders we found only one significant correlation of birth weight with TG for males and females and another one for HDL-C in males. The strongest clustering of significant regression coefficients occurred in the 2nd birth weight quintile for SBP (ß 0.018), TC (ß -0.050), LDL-C (ß -0.039), non LDL-C (ß -0.049) and log TG (ß -0.001) in males and females.

Conclusions: Overall we did not find significant associations between birth weight and nine traditional cardiovascular risk factors in children and adolescents. However, the 2nd quintile of birth weight might suggest clustering of risk factors.

Keywords: Birth weight, CVD risk factors, associations in youths

INTRODUCTION

Low gestational age at birth is independently associated with increased mortality in young adulthood.[1,2] Men with the lowest weight at birth had the highest death rates from ischemic heart disease. The risk of dying from myocardial infarction at 60 years was doubled in men with birth weight of 2500 g or less compared with birth weight of 4300 g or higher.[3] The Nurses Health Study provided strong evidence of an association between birth weight and risk of coronary heart disease and stroke in adulthood.[4] In the Aberdeen children study, birth weight was inversely associated with coronary heart disease (CHD) and stroke with an age-adjusted odds ratio of 0.62 respectively 0.38 for a 1-kg increase.[5] A systematic review of 18 studies concluded that one kg higher birth weight was associated with a 10-20% lower risk of subsequent CHD.[6] The association of low birth weight

Access this article online

Quick Response Code:

Website: www.ijpvmjournal.net/www.ijpm.ir

DOI: 10.4103/2008-7802.172373

with cardiovascular disease (CVD) risk factors including elevated blood pressure, high BMI, and dyslipidemia is controversial.[7-28] There is growing interest in the extent to which body composition differs in infants and children born at the extremes of birth weight. The discrepancies in birth weight are primarily attributable to differences in lean body mass and only to a limited extent to fatness.[28] Preterm infants have less lean tissue but more similar fat mass.[29] Small birth weight is associated with some, but not all components of metabolic syndrome.[30]

Because data on the impact of low birth weight on the development of CVD risk factors in youths are sparse and controversial, we investigated the association of birth weight with anthropometric and laboratory risk factors in urban German children and adolescents participating in the PEP Family Heart Study.[31]

METHODS

We enrolled 843 German youths (435 boys and 408 girls) with reported birth weight and nine CVD risk factors. The 310 children (aged 3-11 years) and 533 adolescents (aged 12-18 years) were categorized according to their birth weight into quintiles for boys (group I <3050 g, group II 3050-3369.5 g, group III 3369.5 -3576 g, group IV 3576-3866 g and group V >3866 g) and for girls (group I <2940 g, group II 2940-3210 g, group III 3210-3450 g, group IV 3450-3700 g and group V >3700 g). We measured body mass index (BMI), waist circumference (WC), blood pressure (BP), total cholesterol (TC), LDL-Cholesterol (LDL-C), HDL-Cholesterol (HDL-C), non HDL-Cholesterol and triglycerides (TG) as previously described.[31-34] Cardiovascular risk factors were defined as overweight (85th - 95th percentile BMI), obesity ≥95th percentile BMI,[35] abdominal adiposity >90th percentile WC,[36] Hypertension as SBP and/or DBP >95th percentile,[37] dyslipidemia in terms of TC ≥200 mg/dL, LDL-C ≥130 mg/dL, HDL-C <40 mg/dL, non HDL-C ≥126 mg/dL, TG ≥100 mg for ages 0-9 years respectively TG ≥130 mg/dL ages 10-19 years.[32]

For statistical analysis, we used SPS 21. Pearson's correlation coefficient was used to correlate birth weight with anthropometric and laboratory variables. The independent association between birth weights with the above variables was calculated including birth weight outliers using linear regression model. Two sided $P < 0.05$ was considered significant.

RESULTS

Mean values and prevalence of anthropometric and lipid values were equally distributed over five birth weight groups of 843 children and adolescents aged 3-18 years [Table 1]. Though the majority of maximal values occurred in the 4th quintile, scatter diagrams demonstrate that risk variables cluster between 3.0 kg to 4.0 kg of birth weight as exemplified for blood pressure in Figure 1. The nearly equal distribution of the nine risk variables over the birth weight quintiles is illustrated by box plots [Figure 2].

Among the correlations of birth weight with the nine risk variables only TG in both genders and HDL-C in males were significant [Table 2a]. The age adjusted regression for birth weight and SBP is exemplified in Figure 3. Significant regression coefficients with birth weight occurred for BMI, WC and log TG in females, for HDL-C in males and for TG [Table 2b]. However, the 2nd birth weight quintile had the closest association with SBP, TC, LDL-C, non LDL-C and log TG in both genders [Table 2c].

DISCUSSION

This study describes the relationship between birth weight quintiles and blood pressure, serum lipids, BMI and WC in 843 youths. Altogether, we did not find clear associations between birth weight and CVD risk factors in children and adolescents which is consistent with published literature.[9,16,19,20] However, because five from nine regression estimates were significant for the 2nd birth weight quintile in both genders, the corresponding birth weight of 3.05-3.40 kg in males and 2.94 – 3.21 kg in females might be predictive for increased CVD risk.

Regarding lipids, a systematic review of 79 studies concluded that low birth weight does not have effects on blood cholesterol levels that would have material impact on CVD risk because 1 kg lower birth weight may be associated with only ~2.0 mg/dL higher TC. Associations with birth weight were provided for HDL-C, LDL-C and TG with heterogeneous outcome for HDL-C in terms of 34 studies without association, 6 studies with inverse and 6 studies with a positive association with birth weight, for LDL-C 23 studies without, 10 studies inverse and 1 study with a positive association and for TG 27 studies without, 15 studies inverse and 1 positive study.[19] We found significant regression coefficients between the 2nd birth weight quintile and TC (ß -0.050), LDL-C (ß -0.039), non LDL-C (ß -0.049) and log TG (ß -0.001). Another review in youths does also not provide strong evidence of a consistent relationship between birth weight and blood lipid concentrations.[20]

Though we observed significant regression coefficients in the 2nd birth weight quintile for SBP (ß 0.018) in males and females, our BP data are consistent with studies which found no association between birth weight and

Table 1: Characteristics and prevalences of 435 boys and 408 girls by quintiles of birth weight; #maximal values

Boys	**GROUP I <3050 g**	**GROUP II 3050-3369.5 g**	**GROUP III 3369.5-3576 g**	**GROUP IV 3576-3866 g**	**GROUP V >3866 g**
n	97	97	80	80	81
Age (year)	13.0 (3.0)	13.4 (3.2)	13.0 (3.3)	12.9 (2.8)	12.9 (3.5)
Height (cm)	158.0 (15.9)	162.0 (16.7)	160.3 (18.9)	162.6 (14.7)#	161.6 (20.1)
Weight (kg)	50.0 (17.0)	54.1 (16.9)	52.3 (18.5)	54.0 (16.3)	54.7 (20.3)#
BMI (kg/m^2)	19.4 (3.6)	20.0 (3.3)	19.6 (3.7)	19.9 (3.2)	20.1 (3.7)#
Overweight (%)	8.5	8.5	9.8	11.5	10.4
Obese (%)	5.1	6.9	3.8	6.0	4.9
WC (cm)	70.4 (10.8)	72.1 (10.1)	71.4 (11.0)	72.2 (9.4)	72.4 (11.2)#
WC >90th percentile (%)	8.0	11.2	7.7	11.7	11.0
SBP (mmHg)	111.3 (13.4)	113.3 (13.7)#	111.9 (14.8)	111.6 (13.2)	111.8 (13.1)
DBP (mmHg)	71.8 (8.5)	70.8 (7.5)	71.4 (9.9)	72.8 (8.4)#	70.9 (8.6)
Hypertension (%)	8.2	8.2	3.8	7.5	3.8
Total cholesterol (mg/dL)	153.6 (28.3)	153.2 (29.8)	158.0 (28.3)	159.1 (31.3)#	152.3 (28.2)
TC >200 mg/dL (%)	5.2	1.0	7.5	5.0	7.4
LDL-cholesterol (mg/dL)	84.4 (23.3)	87.2 (27.6)	88.5 (23.2)#	90.8 (26.8)	86.1 (25.3)
LDL-C >130 mg/dL (%)	4.1	3.1	6.3	5.0	6.2
HDL-cholesterol (mg/dL)	55.0 (10.9)#	52.5 (7.0)	55.3 (10.9)	54.4 (11.0)	53.2 (9.2)
HDL-C <40 mg/dL (%)	6.2	2.1	5.0	6.3	7.4
NonHDL-C (mg/dL)	98.5 (23.6)	100.7 (28.5)	102.7 (24.5)	104.7 (28.0)#	99.0 (24.5)
NonHDL-C >126 mg/dL (%)	4.1	2.1	6.3	7.5	4.9
Triglycerides (mg/dL)	70.8 (33.7)	67.6 (23.2)	71.0 (24.4)#	69.6 (25.4)	70.6 (27.0)
TG >100/130 mg/dL (%)	5.3	2.1	2.5	2.5	3.7
Girls	**GROUP I <2940g**	**GROUP II 2940-3210g**	**GROUP III 3210-3450g**	**GROUP IV 3450-3700g**	**GROUP V >3700g**
n	78	75	90	85	80
Age (year)	13.2 (3.2)	13.0 (3.6)	12.9 (3.1)	13.1 (3.5)	12.3 (3.4)
Height (cm)	155.3 (13.6)	152.4 (14.5)	155.5 (14.7)	156.3 (15.0)#	155.0 (15.1)
Weight (kg)	49.2 (18.1)	45.9 (13.9)	46.7 (13.1)	50.7 (14.5)#	48.7 (15.1)
BMI (kg/m^2)	19.8 (5.0)	19.3 (3.5)	18.9 (2.8)	20.3 (3.6) #	19.7 (3.4)
Overweight (%)	8.5	7.2	7.8	10.5	6.5
Obese (%)	5.5	4.8	3.0	6.2	7.1
WC (cm)	70.9 (13.0)	68.6 (10.3)	68.7 (8.2)	71.2 (9.9)#	69.7 (9.9)
WC >90th percentile (%)	12.3	12.1	9.0	13.1	11.8
SBP (mmHg)	110.8 (12.3)#	105.9 (9.3)	106.5 (10.1)	107.2 (12.0)	107.3 (10.8)
DBP (mmHg)	71.7 (9.8)#	67.3 7.3)	68.1 (7.3)	69.8 (8.1)	70.4 (8.0)
Hypertension (%)	5.1	4.0	4.4	8.2	6.3
Total cholesterol (mg/dL)	162.4 (29.2)	165.6 (26.7)	169.4 (29.1)#	166.4 (30.4)	160.2 (19.4)
TC >200 mg/dL (%)	7.7	6.7	12.2	15.3	2.5
LDL-Cholesterol (mg/dL)	91.9 (25.5)	95.7 (20.9)	97.3 (23.9)#	94.5 (23.7)	91.5 (16.6)
LDL-C >130 mg/dL (%)	5.1	8.0	11.1	7.1	1.3
HDL-Cholesterol (mg/dL)	54.8 (9.6)	54.4 (8.5)	56.4 (9.3)	56.5 (9.9)#	55.2 (8.5)
HDL-C <40 mg/dL (%)	6.4	1.3	3.3	3.5	1.3
NonHDL-C (mg/dL)	107.6 (27.3)	111.2 (24.2)	112.9 (26.2)#	109.9 (26.3)	105.1 (17.3)
NonHDL-C >126 mg/dL (%)	9.0	9.3	10.0	11.8	1.3
Triglycerides (mg/dL)	79.6 (38.8)#	77.3 (32.3)	78.3 (32.5)	76.4 (31.2)	67.8 (26.2)
TG >100/130 mg/dL	12.8	4.0	10.0	4.7	2.5

BMI=Body mass index, WC=Waist circumference, SBP=Systolic blood pressure, DBP=Diastolic blood pressure, TC=Total cholesterol, LDL-C=Cholesterol, HDL-C=Cholesterol, TG=Triglycerides

BP values in children.[21] Huxley and coworkers conclude from 55 studies reporting regression coefficients that birth weight is of little relevance to BP in later life.[9] A meta-analysis of 57 observational studies included 27

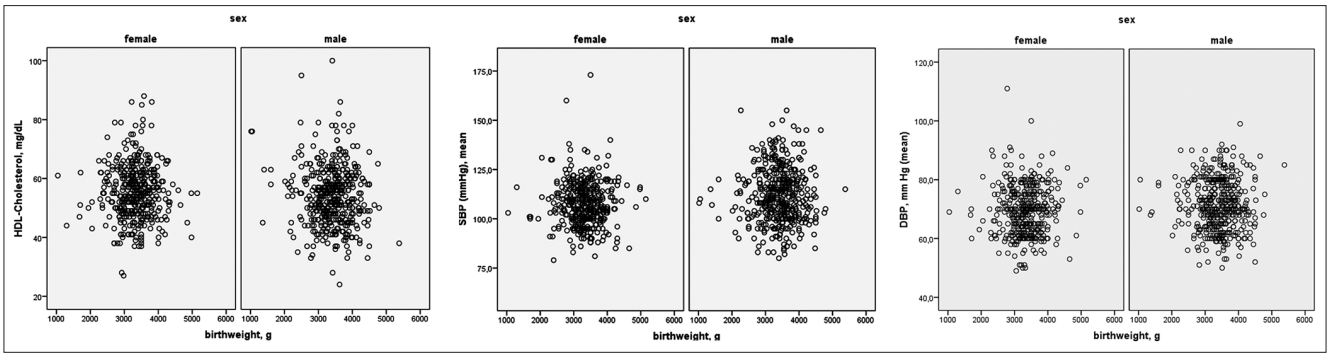

Figure 1: HDL-Cholesterol by birth weight in 435 boys and 408 girls

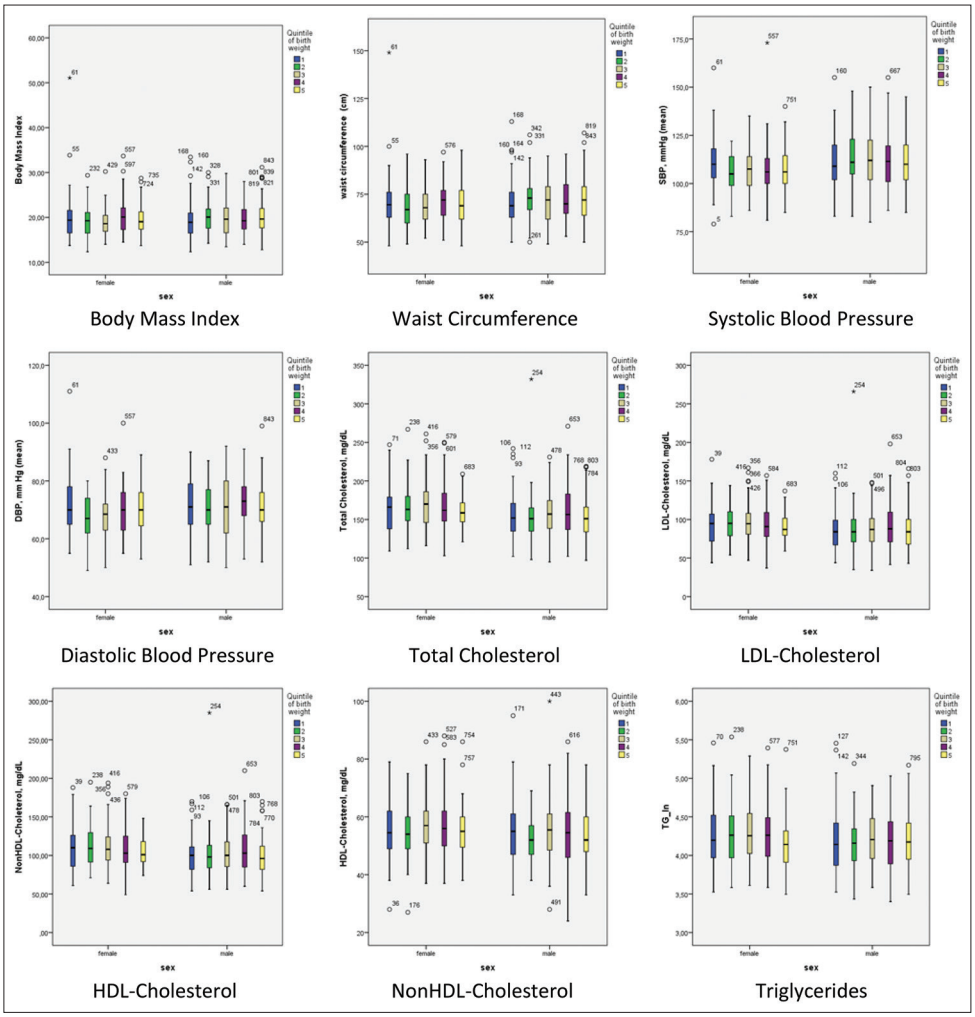

Figure 2: Distribution of Risk Factors by Quintiles of Birth Weight in 435 boys and 408 girls

studies in youth under 18 years which found combined for both genders significant ($P < 0.01$) regression coefficients -1.64 (95% CI 2,16—1.12) for SBP per kg increase in birth weight suggesting chance findings for sex differences.[15] However, a review among 0-71 years old subjects demonstrated that nearly all of the regression coefficients were inversely related typically approximately 2-3 mm Hg/kg in children among 34 studies describing a negative relationship between BP and birth weight in children and adults.[7] Elevated BP in 2.5 year-old children with a mean birth weight of 810 ± 164 g might have implications for cardiovascular health later in life[10] as low birth weight had in African American adolescents.[23] Among 149 newborns who were divided in four birth weight groups there was a positive and independent significant relationship between birth weight and SBP in terms of 1 mm Hg increase for each 125 g within the first year.[26]

Table 2: Correlations, linear regression model for all and linear regression model for five quintiles ; *$P<0.05$

a. Correlations	BMI	Waist	SBP	DBP	TC	LDL-C	HDL-C	Non HDL-C	TG
Birthweight									
r	0.62	0.041	0.006	0.011	−0.042	−0.002	−0.053	−0.028	−0.072*
p	0.071	0.238	0.858	0.74	0.22	0.952	0.128	0.421	0.038
Birthweight ♂									
r	0.047	0.04	0.002	−0.007	−0.024	0.034	−0.09	0.008	−0.04
p	0.331	0.408	0.973	0.884	0.62	0.476	0.06*	0.873	0.408
Birthweight ♀									
r	0.075	0.028	−0.021	0.013	−0.037	−0.024	0.007	−0.044	−0.089
p	0.132	0.578	0.679	0.794	0.457	0.63	0.883	0.378	0.071
b. Linear regressions (age-adjusted)	**BMI**	**Waist**	**SBP**	**DBP**	**TC**	**LDL-C**	**HDL-C**	**Non HDL-C**	**TG ln**
Birthweight all									
ß	0.00002	0.001	0.00005	0.00005	−0.002	0.00009	−0.001	−0.001	0.00005*
p	0.071	0.238	0.858	0.740	0.220	0.952	0.128	0.428	0.027
Birthweight ♂									
ß	0.00004	0.001	0.000	0.000003	−0.001	0.001	−0.002*	0.000	−0.003
p	0,146	0.176	0.762	0.906	0.544	0.515	0.032	0.914	0.226
Birthweight ♀									
ß	0.00004*	0.001*	0.0009	0.001	−0.002	−0.001	0.000	−0.002	−0.00007*
p	0.007	0.009	0.926	0.505	0.499	0.568	0.764	0.389	0.032
c. Linear regressions (age-adjusted)	**BMI**	**Waist**	**SBP**	**DBP**	**TC**	**LDL-C**	**HDL-C**	**Non HDL-C**	**TG ln**
Birthweight 1st quintile									
ß	0.000	0.000	0.003	0.000019	-0.004	0.001	−0.004*	0.000	0.000016
p	0.587	0.918	0.133	0.990	0.512	0.764	0.05	0.986	0.823
Birthweight 2nd quintile									
ß	0.000	0.007	0.018*	0.003	−0.050*	−0.039*	−0.001	−0.049*	−0.001*
p	0.807	0.209	0.01	0.568	0.011	0.021	0.879	0.007	0.004
Birthweight 3rd quintile									
ß	0.003	0.009	0.021*	0.011	−0.040	−0.024	−0.008	−0.032	0.000
p	0.089	0.073	0.007	0.056	0.057	0.156	0.273	0.083	0.062
Birthweight 4th quintile									
ß	−0.002	0.003	0.014	0.012*	−0.041	−0.028	−0.011	−0.030	0.000013
p	0.212	0.583	0.08	0.02	0.053	0.095	0.129	0.106	0.956
Birthweight 5th quintile									
ß	0.001	0.004*	0.0004	0.004	−0.02*	−0.009	−0.007*	−0.013*	−0.000061
p	0.103	0.04	0.280	0.063	0.002	0.103	0.003	0.025	0.477

BMI=Body mass index, SBP=Systolic blood pressure, DBP=Diastolic blood pressure, TC=Total cholesterol, LDL-C=Choleterol, HDL-C=Cholesterol, TG=Triglycerides

A meta-analysis of 643,902 1-75 year-old subjects from 26 countries described that high birth weight increased the risk of overweight in later life and low birth weight might indicate decreased risk of later overweight.[24]

The strengths of this study are a homogeneous setting consisting of sustained staff using the same equipment including auscultatory device and procedures including fasting blood collection in winter and laboratory methods, the representative recruitment of children and adolescents enrolled from 94% of the 54 elementary schools in one city. The weaknesses are missing or incomplete data on length and gestational age were reported from mothers. Furthermore, we did not control for confounding variables such as maternal BP, BMI and smoking status, which are correlated with low birth weight.

CONCLUSIONS

Overall we did not find relevant associations between birth weight and nine cardiovascular risk factors in children and adolescents. This is consistent with published literature. However, the 2nd quintile of birth weight might be suggested to be predictive for a higher risk for CVD.

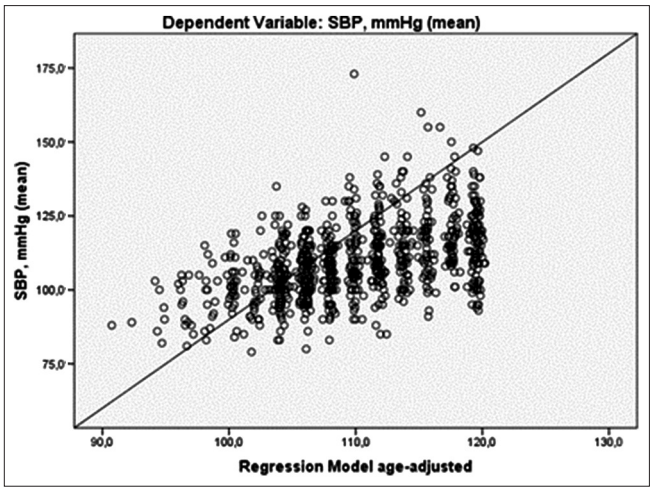

Figure 3: Regression model for linear regression between birth weight (g) and Systolic Blood Pressure in 843 children

ACKNOWLEDGEMENTS

The PEP Family Heart Study is a joint effort of many investigators and staff whose contributions are gratefully acknowledged. We especially thank all authorities and, most importantly, the families for their continuous participation and engagement in this long-term study. The PEP Project was supported by the Foundation for the Prevention of Atherosclerosis, Nuremberg, Germany; the Ludwig Maximilians University, Munich, Germany; the Bavarian Ministry of Health, Munich; the City of Nuremberg, Friedrich-Baur-Stiftung, Banss-Stiftung, LVA Oberbayern, LVA Ober-und Mittelfranken, AOK Bayern.

Received: 28 Feb 15 **Accepted:** 24 Apr 15
Published: 21 Dec 15

REFERENCES

1. De Onis M, Garza Cutberto, Onyango AW, Martorell R. WHO Child Growth Standards. Acta Paediatrica 2006, Supplement 450.
2. Crump C, Sundquist K, Sundquist J, Winkleby MA. Gestational age at birth and mortality in young adulthood. JAMA 2011; 306 (11) 1233-1240.
3. Barker DJP, Winter PD, Osmond C, Margetts B, Simmonds SJ. Weight in infancy and death from ischemic heart disease. Lancet 1989; 334: 577-580.
4. Rich-Edwards JW, Stampfer Meir J, Manson JAE. Rosner B, Hankinson SE, Colditz GA, Hennekens CH, Willet WC. Birth weight and risk of cardiovascular disease in a cohort of women followed up since 1976. BMJ 1997; 315:396.
5. Lawlor DA, Ronalds G, Clark H, Smith GD, Leon DA. Birth weight is inversely associated with incident coronary heart disease and stroke among individuals born in the 1950s. Circulation 2005; 112:1414-1418.
6. Huxley R, Owen CG, Whincup PH, Cook DG, Rich-Edwards J, Smith GD, Collins R. Is birth weight a risk factor for ischemic heart disease in later life? Am J Clin Nutr 2007; 85:1244-50.
7. Law CM, Shiell, AW. Is blood pressure inversely related to birth weight? The strength of evidence from a systematic review of the literature. J Hypertension 1996; 14:935-941.
8. Huxley RR, Shiell AW. Law CM. The role of size at birth and postnatal catch-up growth in determining systolic blood pressure: A systematic review of literature. J Hypertension 2000; 18:815-831.
9. Huxley R, Neil A, Collins R. Unravelling the fetal origins hypothesis: Is there really an inverse association between birth weight and subsequent blood pressure? Lancet 2002; 360: 659-65.
10. Edstedt-Bonamy AK Edstedt, Källén K, Norman M. High blood pressure in 2.5-year-old children born extremely preterm. Pediatrics 2012; 129:e1199-e1204.
11. Hardy R, Wadsworth MEJ, Langenberg C, Kuh D. Birth weight, childhood growth, and blood pressure at 43 years in a British birth cohort International. J Epidemiology 2004; 33:121-129.
12. Miura K, Nakagawa H, Tabata M, Morikawa Y, Nishijo M, Kagamimori S. Birth weight, childhood growth, and cardiovascular disease risk factors in Japanese aged 20 years. Am J Epidemiol 2001;153;783-9.
13. Stein AD, Conlisk A, Torun B, Schroeder DG, Grajeda R, Martorell R. Cardiovascular disease risk factors are related to adult adiposity but not birth weight in young Guatemalian adults. J Nutr 2002; 132:2208-2214.
14. Hack M, Schluchter M, Andreias L, Margevicius S, Taylor HG, Drotar D. Cuttler L. Change in prevalence of chronic conditions between childhood and adolescence among extremely low-birth-weight children. JAMA 2011; 306 (4):394-401.
15. Lawlor DA, Ebrahim S Davey Smith G. Is there a sex differences in the association of birth weight and systolic blood pressure in later life? Findings from a meta-regression analysis. Am J Epidemiol 2002; 156:1100-1104.
16. Daly B, Scragg R, Schaaf D, Metcalf P. Low birth weight and cardiovascular risk factors in Auckland adolescents: A retrospective cohort study. The New Zealand Med J 2005;118: No 1220.
17. Messiah SE, Arheart KL, Lipshultz SE, Bandstra ES, Miller TL. Perinatal factors associated with cardiovascular disease risk among preschool-aged children in the United States: An analysis of 1999-2008 NHANES data. Intern J Pediatrics 2012; doi10.1155/2012/157237.
18. Schooling CM, Jiang CQ, Lam TH, Cowling BJ, Au Yeung SL, Zhang WS, Cheng KK, Leung Gm. Estimated birth weight and adult cardiovascular risk factors in a developing southern Chinese population: A cross sectional study. BMC Public Health 2010; 10:270.
19. Huxley R, Owen CG, Whincup PH, Cook DG, Colman S, Collins R. Birth weight and subsequent cholesterol levels. Exploration of the Fetal Origins Hypothesis. JAMA 2004; 292:2755-2764.
20. Lauren L, Jarvelin MR, Elliott P and the EURO-BLCS Study Group. Relationship between birth weight and blood lipid concentrations in later life: Evidence from existing literature Intern J Epidemiol 2003; 32:962-976.
21. Steinthorsdottir SD, Eliasdottir SB, Indridason OS, Palsson R, Edvardsson V. The relationship between birth weight and bloodpressure in childhood: A population-based study. Am J Hyperternsion 2013; 26:76-82.
22. Heys M, Lin SL, Lam TH, Leung GM, Schooling CM. Lifetime growth and blood pressure in adolescence: Hong Kong's "Children of 1997" birth cohort. Pediatrics 2013; 131:e62-e72.
23. Oberg S, Ge D, Cnattingius S, Svensson A, Treiber FA, Snieder H, Iliadou A. Ethnic differences in the association of birtzh weight and blood pressure. Am J Hypertension 2007; 20:1235-1241.
24. Schellong K, Schulz S, Harder T, Plagemann A. Birth weight and long-term overweight risk: Systematic review and a meta-analysis including 643,902 persons from 66 studies and 26 countries globally. PLOS One 2012; 7:e477776, doi: 10.1371.
25. Libby G, McEwan SR, Morris AD, Belch JJF. No difference in the association between birth weight and total cholesterol for males and females, A SHARP (Scottish heart and arterial disease risk prevention) study. Vasc Med 2008;13;271: 271-274, Doi: 10.1177.
26. Lurbe E, Garcia-Vicent C, Torro I, Fayos JL, Aguilar F, Martin de Llano J, Fuertes G, Redon J. First-year blood pressure increase steepest in low birth weight newborns. J Hypertension 2007; 25:81-86.
27. Kelishadi R, Haghdoost AA, Jamshidi F, Aliramezany M, Moosazadeh M. Low birth weight or rapid catch-up growth: Which is more associated with cardiovascular disease and its risk factors in later life? A systematic review and cryptanalysis. Paediatr Int Child Health 2014; Jul 18:204690514Y00000000136.
28. Hediger ML, Overpeck MD, Kuczmarski RJ, McGlynn A, Maurer KR, Davis WW. Muscularity and fatness of infants and young children born small- or large-for-gestational-age. Pediatrics 1998;102;e60.
29. Johnson MJ, Wotto SA, Leaf AA, Jackson AA. Preterm birth and body composition at term equivalent age: A systematic review and meta-analysis. Pediatrics 2012; 130:e640-e649.
30. Harville EW, Srinivasan S, Chen W, Berenson GS. Is the metabolic syndrome

a "small baby" syndrome? The Bogalusa Heart Study. Metabolic Syndrome and related disorders 2012;0:413-421.
31. Schwandt P, Geiss HC, Ritter MM, Üblacker C, Parhofer KG, Otto C, Laubach E, Donner MG, Haas GM, Richter WO. The prevention education program (PEP). A prospective study of the efficacy of family-oriented life style modification in the reduction of cardiovascular risk and disease: Design and baseline data. J Clin Epidemiol. 1999; 52: 791-800.
32. Schwandt P, Bischoff-Ferrari HA, Staehelin HB, Haas GM. Cardiovascular risk screening in schoolchildren predicts risk in parents. Atherosclerosis 2009: 250: 626-631.
33. Haas GM, Liepold, Schwandt P. Predicting cardiovascular risk factors by different body fat patterns in 3850 German children: The PEP Family Heart Study. Int J Prev Med 2011;2:15-19.
34. Schwandt P, Bertsch T, Haas GM. Anthropometric screening for silent cardiovascular risk factors in adolescents: The PEP Family Heart Study. Atherosclerosis 2010; 211:667-671.
35. Ogden CL, Felgal KM. Changes in Terminology for childhood overweight and obesity. National health statistics reports; no 25. Hyattsville, MD: National Center for Health Statistics. 2010.
36. Zimmet P, Alberti G, Kaufman F, Tajima N, Silink M, Arsolanian S, Wong G, Bennett P, Shaw J, Caprio S, on behalf of the International Diabetes Federation Task Force on Epidemiology and Prevention of Diabetes. The metabolic syndrome in children and adolescents. Lancet 2007;369:2059-2061.
37. McCarthy HD, Ashwell M. A study of central fatness using waist-to-height ratios in UK children and adolescents over two decades supports the simple message – 'keep your waist circumference to less than half your height'. Intern J Obesity 2006;30:988-992.
38. The Fourth Report on the Diagnosis, Evaluation and Treatment of High Blood pressure in Children and Adolescents. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. Pediatrics 2004;114:555-76.

Source of Support: Nil, **Conflict of Interest:** None declared.