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Influence of low birth weight on blood pressure and kidney volume in healthy 2–3 years old children

Wpływ małej masy urodzeniowej na ciśnienie tętnicze i objętość nerek u zdrowych dzieci w 2. i 3. roku życia

Monika Pawlak-Bratkowska [1], *Małgorzata Stańczyk* [1,*], *Dobromiła Barańska* [2], *Anna Kałużyńska* [3], *Anna Stańczyk-Przyłuska* [1,4], *Jolanta Lukamowicz* [5], *Aneta Czupryniak* [3], *Marcin Tkaczyk* [1,6]

[1] *Department of Paediatrics and Immunology with Nephrology Division, Polish Mother's Memorial Hospital Research Institute, Lodz, Poland*
[2] *Department of Imaging Diagnostics, Polish Mother's Memorial Hospital Research Institute, Lodz, Poland*
[3] *Paediatric Ward, District Hospital of Tomaszow Mazowiecki, Poland*
[4] *Department of Paediatrics, Preventive Cardiology and Immunology of Developmental Age, Medical University of Lodz, Poland*
[5] *Medical Laboratory Diagnostics Center, Polish Mother's Memorial Hospital Research Institute, Lodz, Poland*
[6] *Department of Didactics in Paediatrics, Medical University of Lodz, Poland*

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ABSTRACT

Introduction: The influence of low birth weight on development of hypertension and chronic kidney disease progression was confirmed in adolescent and adult population. There has been scarce data published on this topic in younger children and toddlers. **Purpose:** The aim of the study was to assess the influence of low birth weight on blood pressure and kidney volume in youngest children. **Material and methods:** The study group consisted of 38 children (2–3 years), born with low birth weight. The control group consisted of 35 children, born with normal birth weight. Kidneys size and volume were assessed in ultrasonography. Serum cystatin and urine albumin concentrations were assessed. Blood pressure was taken on 4 limbs with oscillometric method. **Results:** There was tendency for the study group to have lower weight (Z-score −1.1418 *vs.* −0.5092, $p = 0.0507$). They have lower height and lower head and chest circumference. They tended to have lower total kidney volume (52 474 mm^3 *vs.* 57 451 mm^3, $p = 0.055$), but that relation disappeared after adjustment to body height. There was no significant difference in blood pressure values and between GFR

* *Corresponding author at*: Klinika Pediatrii, Immunologii i Nefrologii ICZMP, ul. Rzgowska 281/289, 93-338 Łódź, Poland. Tel.: +48 42 271 13 94; fax: +48 783 937 788.
E-mail address: mbstanczyk@gmail.com (M. Stańczyk).

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estimated with Filler formula (125.9 *vs.* 134.2, $p = 0.16$). **Conclusions:** Presented study revealed no significant influence of low birth weight on kidney size and function in children in 2nd and 3rd year of life.

Introduction

Fetal development *in utero* depends on environmental and genetic factors. Recently, factors acting during prenatal life are considered to have influence on pathogenesis of many diseases of adulthood. These have essential meaning in development of hypertension, cardiovascular diseases, diabetes mellitus type 2 and kidney diseases [1].

Through last years it has been revealed that developing fetus adjusts the growth dynamic to environmental conditions. It has been proven on animal models that mothers malnutrition during pregnancy, especially low-protein diet throughout second half of pregnancy, has negative influence on intrauterine fetus growth development [2]. Similarly, disturbances of placental blood flow and glucocorticosteroids administration during pregnancy could lead to growth retardation and abnormal development of certain organs, such as kidneys, pancreas, heart and brain [2, 3]. In experimental studies featuring rats the association between low birth weight and hypertension has been proven. It is connected with factors acting during nephrogenesis, that is mainly (in 60%) throughout the third trimester in humans, that cause decrease of nephron number [4]. This leads to reduction of kidney filtrating capacity and results in deterioration of kidney sodium transport. Natriuresis impairment is followed by increase of systemic blood pressure regulated by renin–angiotensine–aldosterone system and pressure inside kidney glomeruli causing hyalinosis [2, 3].

Several epidemiological studies raised an association between low birth weight (LBW), especially intrauterine growth retardation (IUGR), and elevated systolic blood pressure in children before puberty and evident hypertension in adults [4–6]. Kidney biopsy in individuals with hypertension proved decreased amount of nephrons and glomeruli of greater size in those who were born with low birth weight. It confirms the Baker et al. [6] hypothesis of hyperfiltration due to nephrons deficit. Compensatory overgrowth of glomeruli and hyperfiltration arises from overload of normal nephrons which causes their further hyalinosis and tubular atrophy with concomitant development of inflammatory lesions and fibrosis in interstitial tissue. These lead to further destruction of other nephrons, and this so called vicious circle cause chronic kidney disease progression [4, 7].

The influence of LBW on development of hypertension and chronic kidney disease (CKD) progression was confirmed in adolescent and adult population. There has been scarce data published on this topic in younger children and toddlers. Therefore, we constructed the cross-sectional study in LBW children currently aged 2–3 years without any other risk factors in order to assess the kidney volume and function, with special regard to blood pressure.

Material and methods

The study group consisted of children aged 2 and 3 years, who were participants of cohort of european research program ''Euro Prevall – Food Allergy Across Europe'' [8]. Among these children there were selected 38 who were born between 36 and 42 week of pregnancy with birth weight below 5th percentile.

The control group of 35 children was age-matched (head-to-head) and consisted of children born on term and with normal birth weight.

In all children a perinatal history of mother ilnesses and pharmacotherapy was taken. Anthropometric measurements were performed (body weight and height, head and chest circumference). On the basis of ultrasound examination kidneys sizes were evaluated what enabled to calculate their volume (according to formula: kidney volume = 0.52 × width × thickness × length). Blood pressure was taken on four extremities with automatic oscillometric method (MINDRAY Patient Monitor MEC-1200). Urine albumin was assessed with standard biochemical methods. Serum cystatin C was analyzed with ELISA method (Quantikine ELISA Test, BIOCOM).

As the previous analyzes showed that cystatin-C based GFR estimation is associated with less bias and in children is better indicator of kidney function than creatinine based estimation, authors have decided to use this tool in the study [9, 10]. Glomerular filtration rate was estimated with Filler formula ($eGFR = 91.62 \times (cysC)^{-1.123}$). Exclusion criteria included congenital defects, chronic diseases (especially concerning urinary system, secondary hypertension and cardiac failure), nutrition disturbances and diabetes in mother.

The statistical analysis was performed by Statistica 10 PL software. Median and percentile values were applied to descriptive statistics. Normality of distribution was tested by Shapiro–Wilk test. Parametric test was applied (t-Student). Statistical significance treshold was set at 0.05.

Local Ethical Committee approved the study. Parents of all participants gave an informed consent.

Results

Birth weight of children from the study group was significantly lower compared to control group (2400 g *vs.* 3380 g) what was consistent with premises of the study. Duration of pregnancy was shorter in children from the study group (38 *vs.* 39 hbd, $p < 0.05$). Mothers of children from the study group during pregnancy were more frequently diagnosed with hypertension and other concomitant health problems (single cases of: colitis ulcerosa, hyperthyroidism,