Prematurity Is Not Associated with Intra-Abdominal Adiposity in 5- to 7-Year-Old Children

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Objective To compare body composition and abdominal fat partitioning between 5- to 7-year old children born preterm and born at term. We hypothesized children born preterm to have a higher body fat percentage and higher percentage of intra-abdominal adipose tissue (%IAAT) compared with their peers born at term.

Study design A total of 236 children aged 5-7 years, ie, 116 children born preterm (gestational age 29.8 ± 2.6 [30; 24-33] weeks [mean ± SD {median; range}]) and 120 children born at term were included. Body composition was measured by bioelectrical impedance analysis and %IAAT by magnetic resonance imaging. Body mass index, skin fold thickness, and waist-to-hip ratio were investigated as further measures of body composition. Dietary records were compared between both groups.

Results Children born preterm were shorter (120 cm vs 123 cm, $P < .001$), lighter (21.8 kg vs 24.3 kg, $P < .001$), and had a lower body mass index (15.1 kg/m^2 vs 15.9 kg/m^2, $P = .003$) compared with controls. There were no differences in %IAAT (n = 154), and body fat mass although energy uptake was higher in preterms (335 kJ/kg/d vs 302 kJ/kg/d, $P = .03$).

Conclusions At the age of 5-7 years, children born preterm showed neither increased fat mass nor intra-abdominal adiposity. *(J Pediatr 2013;163:1301-6)*.

Adipose tissue and particularly the intra-abdominal adipose tissue (IAAT) act as an endocrine organ that secretes various bioactive proteins, collectively referred to as adipokines. Adipokines have been shown to modulate insulin sensitivity and to influence fat metabolism. Adipokines have been shown to exhibit direct actions on endothelial function, vascular homeostasis, and atherogenesis, which are independent of their effects on glucose and fat metabolism. Adipokines thus play an important role in the pathogenesis of obesity-related conditions, such as insulin resistance and cardiovascular disease, even in the absence of overweight.[1-4]

Preterm infants have been shown to have higher body fat percentage[5-9] and IAAT[10] at the age when they reach term compared with infants born at term. If differences in body composition and, in particular, an increase in IAAT persisted beyond the neonatal period, preterm infants might be at risk for developing impaired glucose tolerance and cardiovascular disease later in life as indicated by several studies.[11-15]

Beyond the neonatal period, body composition has been shown to change during the first months of life in preterm children.[16-18] In older children, data on body composition are scarce and data on IAAT are missing.

The aim of this study was to compare body composition and IAAT between 5- and 7-year-old children born at a gestational age ≤ 33 weeks and a control group born at term. We hypothesized that children born preterm would have a higher percentage of body fat and higher percentage of intra-abdominal adipose tissue (%IAAT) compared with their peers born at term.

Methods

Children were recruited from the region of Hesse, Germany. We aimed to motivate as many parents of children born preterm as possible to participate in the study. Therefore, we chose several ways to recruit children born preterm. In Germany, one way to comprehensively circulate information to parents is the obligatory health examination before school entry, which is performed by the

%IAAT	Percentage of intra-abdominal adipose tissue
BIA	Bioelectrical impedance analysis
BMI	Body mass index
IAAT	Intra-abdominal adipose tissue
MRI	Magnetic resonance imaging
SGA	Small for gestational age
TAAT	Total abdominal adipose tissue

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local public health services. The health examination is obligatory for all children, including mentally and/or physically handicapped children. All public health services within the radius of 120 km distributed information on the study to parents of children born preterm when they showed up for their obligatory health examination. In addition, pediatric offices within the same circumference were asked to distribute information on the study to the parents of children born preterm. Children born at term were also recruited through the obligatory health examinations before school entry as well as via newspaper advertisements.

Because we aimed to have comparable mean ages at the day of examination and comparable sex distributions between the group of children born preterm and the group of children born at term, the last 30 children recruited in the group of children born at term were selected among the applicants in order to approach a comparable mean age and sex distribution between both groups. All children who participated in the study were between 5 and 7 years old at the day of examination. Preterm children of a gestational age of 33 weeks or below were included in the study. The control group comprised children with a gestational age between 37 and 41 weeks.

Exclusion criteria for all children were type-1 diabetes, chromosomal abnormalities, major disability (gross motor function classification system >II),[19] chronic illness, and systemic corticosteroid therapy. All children had to be prepubertal. Gestational age was taken from the hospital birth records. Detailed data concerning pregnancy, perinatal history, previous medical history, nutrition, growth, and weight gain were taken from the documents of the obligatory well-child visits and were complemented by information obtained from medical records. Additional information on the child's history as well as on family history and current parental weight and length was obtained by a structured interview at the day of examination. Being born small for gestational age (SGA) was defined as a birth weight below the 10th percentile according to the percentiles of Voigt[20] for German newborns. Accelerated weight gain during infancy was defined as an increase in the percentile values of more than 25 percentiles between birth and the first birthday (eg, from a birth weight corresponding to the 15th percentile to a weight at age 1 year corresponding to the 41st percentile).

A family history of cardiovascular disease was ascertained if 1 or more first or second degree relatives had suffered coronary heart disease and/or myocardial infarction and/or stroke.

A 3-day, semiquantitative diet diary was kept by the parents. Parents were instructed on how to record meals and food items and to keep the diary as detailed as possible. Among others, the diary had to contain information on weights or serving sizes, volumes, and household measures. Specifications on food items including fat content (eg, milk products) as well as brand names had to be outlined. Dietary diaries were then coded by a trained nutritionist using DGE-PC professional software, v. 4.1 (GOE, Linden, Germany). This software also includes conversions of serving sizes, which were specified by the parents as small, medium, or large portions for adults being equivalent to 50%, 75%, and 100% of adult serving sizes, respectively. The coding of the energy content is based on the basis of the German Food Code and Nutrient Data Base Bundeslebensmittelschlüssel (BLS) II.3.[21] For new items, consumer information on energy content given on the food packing was used.

All investigations were undertaken in the Pediatric Center of the Justus-Liebig University, Giessen, Germany, between June 2008 and August 2009.

The study was approved by the local research ethics committee and written parental consent was obtained.

Body weight and length were measured as recommended by Stolzenberg et al[22] and body mass index (BMI) was calculated.[23] Percentiles were assessed using the references of Kromeyer-Hauschild et al.[24] Waist and hip circumferences and the calculation of the waist-to-hip ratio were assessed as described previously.[25]

Body fat was estimated by bioelectrical impedance analysis (BIA) (Nutriguard-S, NutriPlus 5.3.0; Data Input GMBH, Darmstadt, Germany) after an overnight fast of at least 8 hours and resting 10-15 minutes lying supine.[26] Body fat (%) based on BIA was calculated according to the formula described in Plachta-Danielzik et al,[27] which was validated for German children and adolescents aged 4-16 years.

Bicips, tricips, suprailiac, and subscapular skinfolds were measured using a Holtain caliper (Holtain Ltd, Crymych, United Kingdom) as described previously.[25] Based on the tricips and subscapular skinfold thickness, body fat was calculated using the formula of Slaughter et al.[28]

Body fat estimated by BIA and skinfold measurements was expressed as fat mass index (fat mass [kg]/height [m]^2).[29] This approach gives consideration to the fact that two individuals may differ considerably in their amounts of fat and lean tissue yet may share the same percentage total body fat by virtue of the fact that one is much lighter than the other.

Adipose tissue was assessed by magnetic resonance imaging (MRI) using a 3.0 Tesla system (MAGNETOM Verio, Siemens, Erlangen, Germany). Measurements were performed without sedation with the child positioned supine with the arm parallel to the body in a phased array cardiac coil. The MRI sequence used in this study was adapted from previously developed scanning protocols. We defined the ratio of intra-abdominal vs subcutaneous fat at a defined level of the middle abdomen. The measurement of fat distribution from a single location (at the level of L4/L5) has a strong correlation with measurements of entire abdominal fat.[30] We performed a localizer and at the level of the middle of the third and fourth lumbar vertebra three adjacent slices (5 mm slice thickness; gap 0.5 mm, repetition time/echo time (ms), 3.89/1.7, flip angle 50°, matrix 320 × 256, with a typical field of view of 306 × 240 mm and an acquisition time of 4.1 s using a phased array cardiac coil). The measurement was repeated with a spectral fat saturation mode. All images were analyzed by the same physician who was blinded to the child and used software provided by the manufacturer (Syngo MR B17 software; Siemens). The three images and