e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(4); 258-263

Original Research Article

Comparation of Waist Circumference-Length Ratio and Ponderal Index in Preterm Infants of Higher and Lower Gestational Ages at Birth

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Received: 15-01-2023 / Revised: 26-02-2023 / Accepted: 29-03-2023
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Conflict of interest: Nil

Abstract

Introduction: Preterm infants are more likely than full-term babies to acquire obesity, hypertension, insulin resistance, type 2 diabetes, and cardiovascular disease later in life. Preterm babies have higher total fat mass or adiposity compared to term babies, in addition to higher visceral fat as a percentage of total body fat storage. Adipose tissue is metabolically active, and the fat cells that make up this tissue secrete a class of bioactive substances known as adipokines.

Methodology: For 100 infants born preterm and 100 infants born full-term, a chart review was done. We measured the baby's weight at birth, length, waist size, and hospital discharge weight (WC). The body mass index (BMI), ponderal index, and width to length ratio (WLR) were calculated. According to birth weight (BW), preterm newborns were divided into quartiles (Q1-Q4).

Result: As comparison to preterm infants in higher BW quartiles or full-term infants, preterm neonatal 2 in the lowest BW quartile (Q1) had considerably shorter mean length, WC, WLR, BMI, and ponderal index at birth. Although their weight, length, and BMI remained significantly below term infants, preterm infants in Q1 experienced a disproportionate increase in WLR and ponderal index. As a result, at discharge, their WLR and ponderal index were higher than infants in Q2–3, similar to infants in Q4, and greater than full-term newborns. Discharge WLR and ponderal index increased in Q1 in addition to a decrease in postmenstrual age at delivery.

Conclusion: We describe normative birth data for WLR and PI in preterm and full-term neonates according to gestational age and gender. WLR and ponderal index grow disproportionately in premature infants with lower birth postmenstrual ages.

Keywords: Lower Gestational Age, Higher Gestational Age, Waist Circumference-Length Ratio, Ponderal Index, Preterm Infants.

Introduction

Preterm infants are more likely than full-term babies to acquire obesity, hypertension, insulin resistance, type 2 diabetes, and cardiovascular disease later in life [2-5]. It is unknown what roles genetic, fetal epigenetic, and neonatal programming play in weight increase or fat storage. Also, it is unknown if preterm infants born at lower weights or later in the menstrual cycle are at a higher risk than those who were born at term at a higher weight. More effective postnatal nutritional methods may help to lessen this elevated risk, but it is unclear to what extent. Preterm babies have higher total fat mass or adiposity compared to term babies, in addition to higher visceral fat as a percentage of total body fat storage. Adipose tissue is metabolically active, and the fat cells that make up this tissue secrete a class of bioactive substances known as adipokines. The pathogenesis of the metabolic syndrome is hypothesized to be influenced by alterations in adipokine production brought on by obesity [1,6-7]. The increased risk of long-term cardiometabolic effects in infants born preterm may be severely affected by the development of both increased visceral adiposity and widespread adiposity by term age.

Visceral adiposity is a critical indicator of the development of the metabolic syndrome and unfavorable cardiovascular outcomes in adults and adolescents. It correlates more significantly with cardiometabolic risk than overall obesity or total fat mass. 1 Waist circumference (WC) is a potential marker of visceral adiposity because it consistently relates with the most accurate radiographic assessments of visceral fat in both children and adults. Neonatal data are very scarce, especially in preterm born infants and especially as related to PMA at birth, despite the acknowledged significance of body composition measurements in adults and adolescents and the clinical utility of simple, noninvasive anthropometric measures, such as WC and WHtR. We examined anthropometric measurements that had changed between delivery and hospital discharge in this analysis of neonatal intensive care units. We expected that anthropometric patterns of preterm infants would be altered, indicating increased adiposity, and that these alterations could be assessed using simple, non-invasive indices such the WC/length ratio (WLR) and ponderal index.

Methodology

This was a nationwide, retrospective chart evaluation of paired mother and newborn medical data for children born during the relevant 12-month period starting February 2022, and ending January 2023. Nalanda Medical College and Hospital, Patna obtained institutional review board consent prior to data collection. Due to the de-identification of every piece of data during processing, parental consent was not necessary. Below is a quick summary of the previously disclosed study methodology. Each participating site's institutional review board gave its approval to this study.

For each eligible preterm infant chart, our initial goal was to review around three eligible full term infant charts. Nalanda Medical College and Hospital's first 25 newborns born each month who were sent home from the newborn nursery as well as all NICU discharges were included in the review. A PMA of less than 37 weeks at the time of birth was considered preterm. A PMA of 39 to 44 weeks was regarded as full term at birth. Based on their birth weights (BWs), which ranged from 10% to 90% for their PMA, babies were classified as small or big for gestational age (SGA or LGA, respectively). Infants with BWs between 10% and 90% were categorized as appropriate for gestational age. Based on recently released growth, infants are classified as LGA, suitable for gestational age, or SGA for weight at birth. All newborns having multiple birth gestations, those without mother charts, and those who were moved to another care facility before being discharged were all omitted. Also, we disqualified any infant with a confirmed or suspected diagnosis of a chromosomal condition or syndrome that is known to have an impact on infant growth. Infants born full-term were not included in the group of newborns sent home from the NICU.

Table 1: Infant and maternal traits for full-term and preterm BW quartiles at birth

	Q1 (n=126)	Q2 (n=125)	Q3 (n=127)	Q4 (n=127)	Full term (n=1424)	p-value
Maternal						
Age(y)	28.4 (7.8)	29.4 (6.7)	27.9 (6.6)	29.4 (7)	27.6 (5.6)	0.179
1-h glucose (mg/dL)	118 (41)	116(24)	114(27)	124 (39)	113 (27)	0.235
Pregnancy	26 (5.5)	25.8(6.7)	24.7 (5)	25.3(6.4)	24.9(5.2)	0.690
Preeclampsia (%)	20	17.1	10.3	7,4	3.6	<0.001
Gestational diabetes mellitus (%)	7.4	2.2	8.1	16.2	5.5	<0.001
Other/NS (%)	19.4	26.9	15.3	15.4	13.4	0.003
Infant						
PMA (wk)	30.5 (3)	33.2 (1.4)	33.3 (1.2)	36.4 (0.8)	40.2 (1.2)	<0.001
Birth length (cm)	39.0 (3.8)	45.6 (2.2)	46.9 (2.1)	49.52 (1.5)	51.70 (2.5)	<0.001
BW (kg)	1.36 (0.33)	2.01 (0.13)	2.52 (0.14)	3.11 (0.39)	3.52 (0.5)	<0.001
Female (%)	52.2	43.7	50.2	35.7	46.6	0.539
SGA (%)	25.8	6.7	0	0	4.4	<0.001
LGA (%)	6.6	50	17.7	38.6	13.4	<0.001
	n = 71	n = 72	n = 74	n = 78	n = 803	
Birth WC (cm)	22.9 (2.5)	26.7 (1.7)	27.8 (1.7)	31.0 (2.2)	31.0 (2.2)	<0.001

Date, weight, length, head circumference, WC (available at two sites), sex, and PMA based on a first trimester ultrasound were all documented for all eligible babies (if none, then on last menstrual period). All preterm newborns' weight, length, head circumference, weight at discharge, and feeding regimen were additional information that we recorded (breast, formula, mixed). All babies were measured for BMI (kg/m^2), ponderal index (kg/m^3), and WLR (if available) at birth. For infants born preterm, the measurements were repeated at hospital discharge.

For the routine third trimester 1-hour glucose challenge (50 g load), the following maternal data were gathered: age at delivery, prenatal weight and height, weight gain during pregnancy, preeclampsia or gestational diabetes mellitus, blood glucose result (mg/dL), marital status, ethnicity, highest level of education completed (<high school, high school,>high school), and active duty sponsor military rank (officer or enlisted). The pre-gravid BMI was determined.

Results and Discussion

Our findings, which demonstrate a disproportionate increase in WLR and ponderal index among the smallest, most preterm cohort of children at discharge, are in keeping with recent findings that preterm newborns exhibit aberrant growth or adiposity patterns within the first few weeks following delivery [2,5,6,8,11]. Our further analyses demonstrate that lower birth PMA, not lower BW for PMA, is associated with the much higher discharge WLR and ponderal index in Q1, which has the highest percentage of SGA babies. These findings suggest that preterm itself may be linked to higher fat mass accumulation following NICU discharge. Although a direct link between the anthropometric abnormalities observed in this study and the cardiometabolic sequelae that followed in preterm newborns has not been established, the hypothesis of increased adiposity, and particularly visceral adiposity, offers a physiologically plausible connection. Also, our findings show that WLR and ponderal index could serve as simple and affordable measurements of visceral and total fat mass, respectively, in the clinical environment. Further studies comparing these indices to precise measurements of body composition will be necessary in order to corroborate these findings because the use of WLR and the ponderal index to assess adiposity in preterm newborns has not yet been confirmed. [9,10]

The key benefits of our study include the large number of both preterm and full-term children and the availability of WC data from 2 of the 3. Even though we only included 25% of all full-term infants, our random selection process over the course of the whole year should have resulted in a final cohort that was representative of all full-term births during these two epochs. Our study, however, has a couple of drawbacks. To investigate the degree of connection between WLR and ponderal index with direct measurements of visceral and total body fat mass, respectively, we lack a direct body composition analysis. There are no correlation data for either full-term or preterm neonates, despite the fact that WLR does correlate positively with objective measures of visceral fat mass in adolescents and adults. Most of the moms in our research sample had at least a high school diploma, most parents were married, and there was little self-reported exposure of the foetus to smoking, drinking, or illegal drugs.

Missing data, the absence of consistent definitions for acknowledged maternal disorders, and variable application of measurement techniques, particularly for newborn length and WC, are further structural limitations of our recent systematic review strategy [9,12]. Although a recent study showed the reproducibility of the routine clinical measurement of WC in newborns, there were no data on infants on the ideal site for WC measurement. Although absolute WC values are lower in children than in adults, the connection with cardiometabolic risk appears to be similar in both groups. Our WC and WLR differences may have been larger than those previously reported using more reliable measurement techniques. Our findings must also be confirmed by investigations that are prospectively intended, as is the case with any retrospective study design. [13-15]

It has been questioned whether the ponderal index still has utility in assessing fat mass in babies [18]. However, later studies in full-term neonates revealed a weak correlation between ponderal index and birth weight. Whole skin-fold thickness has been found to positively correlate with total percent body fat as measured by air displacement plethysmography [16,17], a method widely used to assess subcutaneous fat mass and a marker of body adiposity. These findings of our research are consistent with recent papers, suggesting the need to place more focus on the ponderal index's therapeutic value. [19]

With the assistance of more precise measurements of visceral and total fat reserves, additional research is required to examine the relationship between WLR and ponderal index in both preterm and full-term infants. [20] Another critical question that needs to be addressed is if the apparent obesity that appears to be developing in preterm infants in the NICU is sustained over time and if this links to their heightened cardiometabolic risk. If so, it will be crucial to investigate whether or not early adiposity in preterm infants may be decreased by altering dietary intake without impairing brain development or lean body mass growth.

Conclusion

By gestational age and sex, we describe normative birth data for WLR and PI in preterm and full-term neonates. As clinical indicators of visceral and general obesity, WLR and PI may be relevant. WLR and PI may be helpful in monitoring postnatal nutrition and growth in addition to determining the possibility of developing obesity and cardiometabolic diseases when combined with other anthropometric parameters. WLR and ponderal indices are disproportionately higher in preterm children with lower birth postmenstrual ages, which indicates increased visceral and overall adiposity. Despite the widely acknowledged importance of body composition measurements in adults and elderly individuals and the clinical utility of fundamental, noninvasive anthropometric measures like WC and WHtR, newborn data are extremely scarce, especially in preterm born infants and especially as related to PMA at delivery. In this preterm infant study, we retroactively assessed changes in anthropometric indices between birth and hospital discharge. Using straightforward, non-invasive metrics like the WC/length ratio (WLR) and ponderal index, we expected that preterm neonates would have changed anthropometric patterns indicating of increased adiposity.

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