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Serum zinc levels of cord blood: Relation to birth weight and gestational period

Tahiry Gómez[a,*,1], Leticia Bequer[a,2], Angel Mollineda[b,3], Olga González[a,4], Mireisy Diaz[a,5], Douglas Fernández[a,6]

[a] Biomedical Research Center, Medical College of Villa Clara, Cuba
[b] Las Villas Central University, Cuba

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ABSTRACT

Background: Zn-deficiency has been associated with numerous alterations during pregnancy including low birth weight; however, the research relating neonatal zinc status and birth weight has not produced reliable results.

Objective: To compare the serum Zn-levels of cord blood in healthy newborns and low birth weight newborns, and to assess a possible relationship between zinc concentration and neonatal birth weight and gestational age.

Material and methods: 123 newborns divided in "study group" ($n = 50$) with <2500 g birth weight neonates and "control group" ($n = 73$) with ≥2500 g birth weight neonates were enrolled. Study group was subdivided according to gestational age in preterm (<37 weeks) and full-term (≥37 weeks). Serum cord blood samples were collected and the Zn-levels were analyzed using flame Atomic Absorption Spectrophotometry method and the result was expressed in μmol/L. The Zn-levels were compared between the groups (Mann–Whitney-*U* test) and the Zn-levels were correlated with the birth weight and gestational age (Spearman's rank correlations).

Results: Statistically significant low positive correlation between Zn-levels and birth weight ($\rho = 0.283$; $p = 0.005$) was found. No statistically significant difference between Zn-levels of study and control groups [17.00 ± 0.43 vs. 18.16 ± 0.32 ($p = 0.053$)] was found. Statistically significant low positive correlation between Zn-levels and gestational age ($\rho = 0.351$; $p = 0.001$) was found. No statistically significant difference between Zn-levels of preterm as compare to full-term newborns [16.33 ± 0.42 vs. 18.43 ± 0.93 ($p = 0.079$)] was found. Zn-level of preterm subgroup was significantly lower compared to control group ($p = 0.001$).

Conclusions: Despite low birth weight preterm neonates had significantly lower serum zinc levels of cord blood than healthy term neonates, the correlation between cord blood zinc levels and birth weight and gestational age was lower. The results are not enough to relate the change in cord blood zinc concentration to the birth weight values or gestational period. In relation to complicated pregnancies, further studies regarding zinc levels in blood in our population are required.

* Corresponding author. Tel.: +5342273436.
E-mail address: tahirygh@ucm.vcl.sld.cu (T. Gómez).
[1] Address: Calle 4ta, No. 323, e/F y G Rpto. Vigía, CP: 50200 Santa Clara, Villa Clara, Cuba.
[2] Address: Calle B, No. 35 Altos, e/2 da y 3ra. Rpto. Virginia, CP: 50100 Santa Clara, Villa Clara, Cuba.
[3] Address: Carr. Camajuaní. Km 6,5, CPA Camilo Cienfuegos, Santa Clara, Villa Clara, Cuba.
[4] Address: Carr. Maleza Km 91/2, Base Aérea, CPA Frank País, Santa Clara, Villa Clara, Cuba.
[5] Address: Calle A, No. 91 e/Danielito y 3ra. Rpto. Virginia, CP: 50100 Santa Clara, Villa Clara, Cuba.
[6] Address: Edificio 109, Apto 9, Calle 6ta y Doble Vía, Apto 9. Rpto. Vigía Sur, CP: 50200 Santa Clara, Villa Clara, Cuba.

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Introduction

Low birth weight is a phenomenon that impacts greatly on neonatal and infant mortality in children younger than 1 year [1]. Also, children with low birth weight have a considerable morbidity risk; long-term effects of low birth weight affect not only the perinatal period, but also childhood and even adulthood [1–4].

It has been described that micronutrient deficiencies during pregnancy can cause low birth weight [2]. In particular, zinc deficiency has been associated with abnormal conditions during pregnancy including congenital malformations (anencephaly), abortions, intrauterine growth retardation, and prematurity and low birth weight [5–7]. Zinc deficiency has a negative effect on the endocrine system, leading to growth failure. Zinc is a key component of the cell architecture and function; it is required for production of several enzymes which are involved in protein synthesis, nucleic acid metabolism and immune function. In addition it is a structural component of various proteins, hormones and nucleotides [6].

Low zinc concentrations of low birth weight newborns have been noted in a number of settings in both animal and human populations [6,8,9]. In humans, however, the research relating neonatal zinc status and birth weight has not produced consistent results. Many studies establish positive associations between neonatal serum zinc concentration and birth weight [9–11], whereas some studies establish negative associations [12] or did not find significant associations [5,9]. Nevertheless, in most of the studies in humans, the alterations have been associated with severe zinc deficiencies [7,13].

The aim of this study was to compare the serum zinc levels of cord blood in healthy newborns and low birth weight newborns, and to assess a possible relationship between zinc concentration and neonatal birth weight and gestational age.

Methods

This prospective study was conducted at the Biomedical Research Center of Medical College, in conjunction with the Las Villas Central University and the Obstetric and Gynecological Teaching Hospital in Villa Clara, Cuba. The study protocol and informed consent were approved by the Ethics Committee of the Biomedical Research Center, and the consent was given by the mothers before enrollment.

The study included a total of 123 healthy newborns and low birth weight newborns divided into two groups: a "study group" composed of newborns with birth weight <2500 g, included preterm infants and full-term infants, and a "control group" with healthy infants. All cases were uncomplicated singleton pregnancies and all mothers were 18–34 years at the time of delivery.

Births with abnormal maternal conditions such as high blood pressure, heart disease, diabetes mellitus, lupus, malignancies, seizure disorders, drug or alcohol abuse, serologic and HIV positive controls, and clinical conditions known to affect mineral metabolism such as severe malnutrition and severe anemia were excluded.

Medical and social data on mothers were obtained from available information in their records and after delivery birth weight and sex of the newborn were recorded. Blood was drawn from the umbilical cord immediately after delivery and before separating the cord from the placenta, according to the procedure detailed by our research group [14]. After the immediate centrifugation, serum was transferred to deionized tubes, stored and frozen at −20 °C until determination of zinc concentrations was done. Serum zinc concentration was determined by Atomic Absorption Spectroscopy (AAS) with flame atomization.

A Pye Unicam (Cambridge, England) Model SP9 (Philips) Atomic Absorption Spectrophotometer, and zinc hollow-cathode lamps as the radiation source was used. Instrumental parameters were adjusted, for example: wavelength: 213.9 nm, flame: Air/Acet., band pass: 0.2 nm, lamp current: 5 mA.

For calibration, working standard solutions (9.18, 18.36 and 36.72 μmol/L concentrations) were obtained by appropriate dilution of the stock standard solutions of zinc at a concentration of 1000 mg/L (Merck, Darmstadt, Germany). The method of standard addition to a serum pool of cord blood (prepared by our research group) was also used for calibration, according to the method proposed by Ekkehlrd et al. [15].

Working standard solutions and samples were dissolved in a non-ionic surfactant solution Triton X-100, 0.003%, prepared from the commercially available product (BDH Chemicals Ltd., Poole, England). All standards solutions and samples were analyzed in duplicate.

All other reagents were of analytical-reagent grade. All solutions were prepared in ultra-high-quality water. The materials and vessels used for trace analysis were kept in 10% nitric acid for at least 48 h and subsequently washed four times with ultra-high-quality water before use.

Since not all variables showed normal distribution nonparametric tests were applied. Mann–Whitney-*U* test was used to evaluate the difference between the mean zinc concentrations. Spearman's rank correlation (rho[ρ]) was used to determine relation between serum zinc and birth weight, gestational period, maternal age and maternal weight.

Absolute frequencies and percentages for the analysis of qualitative variables were used. Chi-squared test based on hypotheses of homogeneity was used to determine significant differences with respect to qualitative variables selected.

p values < 0.05 were considered significant.

Results

50 out of 123 neonates were included in the "study group" and the rest (73) were included in the "control group". From all 50 newborns included in the study group, 34 were considered preterm infants (≤37 weeks) and the rest [16] were considered full-term (≥37 weeks). The newborns included in the control group were healthy singleton, normal birth weight and full-term newborns. Medical and social data of the study population are shown in Table 1.

Fig. 1 summarizes serum zinc concentration in umbilical cord according to birth weight and gestational age. Cord blood zinc levels according to birth weight were lower in the study group than in the control group, but there was no statistically significant difference between mean zinc levels ($p > 0.05$). The mean zinc levels according to gestational age into the study group were similar ($p > 0.05$) but, as shown in Fig. 1, zinc levels in the preterm sub-group were significantly lower ($p < 0.05$) compared to the control group.

A statistically significant low positive correlation between zinc levels and birth weight and gestational period ($\rho = 0.283$; $p = 0.005$ and $\rho = 0.351$; $p = 0.001$ respectively) was found (Fig. 2). No correlation between zinc levels and maternal age and maternal weight ($\rho = -0.129$; $p = 0.160$ and $\rho = -0.145$; $p = 0.112$) was found.

Discussion

Births with no risk factors considered as a confounding factor that could affect the birth weight and the levels of zinc were included in this study. Results showed no correlation between zinc concentration and maternal age and maternal weight. These results were achieved by rigorous criteria for the inclusion of mothers