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ORIGINAL RESEARCH

Polycythemia in the newborn: prevalence and associated factors.

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Abstract

Introduction: Polycythemia affects 1 to 5% of newborns; it is associated with complications due to organic and systemic involvement in the newborn that can be preventable. This research aimed to determine the prevalence of neonatal polycythemia and its associated factors in newborns in a public maternity service in the city of Cuenca-Ecuador.

Methods: A cross-sectional study was carried out, including all newborns in the maternity service of the Vicente Corral Moscoso Hospital. The sample was probabilistic of 470 neonates and their mothers. To identify an association, we used X^2, and to measure association intensity, OR (95% CI) and *P*-value < 0.05.

Results: Four-hundred-seventy cases were randomly entered into the study. A prevalence of 12.8% was obtained. The 93% maternal residence was above 2000 meters above sea level. The associated factors were: low birth weight (OR 3.8; 95% CI: 1.9 - 7.5) $P < 0.001$, maternal pathology including diabetes (OR 2.6, 95% CI: 1.3–5.2) $P = 0.013$, pregnancy toxemia (OR 2.3; 95% CI: 0.7–7.6) $P = 0.134$, and negative association with prematurity (OR 0.3; 95% CI: 0.07–1.2) $P = 0.099$.

Conclusions: The prevalence of neonatal polycythemia is high and significantly associated with low birth weight and maternal pathology.

Keywords: Polycythemia; Infant, Newborn; Risk Factors; Infant, Extremely Low Birth Weight.

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Introducction

Neonatal polycythemia (NPc) is defined as a venous hematocrit equal to or greater than 65% [1-4].

The increase in hematocrit in the neonate is due to three mechanisms: response to hypoxia, blood transfusions, and hemoconcentration due to decreased plasma volume [3-5]. Associated factors can be either maternal or neonatal factors.

Among the maternal factors, toxemia of pregnancy, placenta previa, advanced maternal age, severe heart disease, smoking mother, diabetes, and use of beta-blockers drugs are described.

The neonatal factors described are: dehydration, small-for-gestational-age neonate, post-term newborn, congenital adrenal hyperplasia, neonatal thyrotoxicosis, neonatal hypothyroidism, Chromopathies (Trisomy 13, 18 and 21), delayed clamping of the umbilical cord, twin-twin transfusion, maternal-fetal transfusion, oligohidramnios, and Beckwith-Wiederman syndrome [6-9].

The prevalence of PCn is influenced by gestational age, birth weight and births in height (meters above sea level [masl]). It occurs in 2% to 4% of normal infants but rises to 10% to 15% in infants small for gestational age and 6% to 8% in children considered large for gestational age. It occurs very rarely in premature infants with a gestational age less than 34 weeks [10-18].

Several epidemiology studies of NPc in the Andean zone and Latin America report prevalences lower than 7% [6-9]. However, there are reports that come out of the regional casuistry possibly associated with altitude; for example, studies carried out in Tibet [10] and Bolivia [11] with prevalences of up to 83%.

In Ecuador, at an altitude of 2560 masl (Cuenca-Azuay), a study carried out at the Vicente Corral Moscoso Hospital in 2017 reported the factors associated with polycythemia in low-birth-weight neonates: small-term newborns for gestational age and perinatal asphyxia [9]. Considering the height of the city of Cuenca-Ecuador of 2560 masl, the hypothesis of this study established the prevalence of NPc greater than 10%, and the objective was to measure the associated factors.

Population and methods

Type of study

The present investigation is transversal.

Study area

The study was carried out in the Maternity Service of the Vicente Corral Moscoso Regional Hospital of the Ministry of Public Health of Ecuador, Cuenca-Ecuador. The study began on May 1, 2018, and ended on May 31, 2019.

Universe and sample

The universe in the study period was made up of all newborns in the institution that consisted of 5150 births. The sample size calculation was probabilistic and was estimated using a 95% confidence level with a type 1 error of 5% and an absolute precision of 2%. The sample size was 429 newborns, to which 10% was added due to eventual loss of information (n = 41), with a final estimate of 470 newborns. The sampling was systematically randomized. For the sample calculation, EPIDAT 3.1 (Sergas, Santiago de Compostela, Spain) was used.

Participants

Neonates between 24 and 42 weeks of gestational age (GA) whose mothers had a medical history from the MSP and the Latin American Center for Perinatology (CLAP) were included. Cases in which the information was not complete in the clinical history or in the CLAP database and neonates with a malformation that produces polycythemia, such as trisomy 13, 18 and 21, were excluded.

Variables

The dependent variable was NPc. The independent variables were consolidated into two groups: maternal characteristics (age, residence, education, gestational age, pregnancy number, weight at the beginning and end of pregnancy, height, hemoglobin before and after 20 weeks of gestation, ethnicity and maternal pathologies) and neonatal characteristics (type of delivery, sex of the newborn, place of care, level of training of the person who attended the delivery, time of delivery, single or twin product, Apgar at 1 and 5 minutes, weight, height, head circumference, lifetime at which the hematocrit was measured, and clinical signs of polycythemia).

Procedures, techniques, and instruments.

The data were collected from the medical records in a form designed exclusively for this purpose. The hematocrit measurement was carried out between 2 to 6 h of the life of the newborns (NB), simultaneously with the extraction of the sample to obtain toxoplasma and VDRL mark-

ers, which are carried out as part of the institutional protocol. Therefore, no blood collection was performed outside of the established protocol. However, it is important to describe how the sample is taken and that residents are previously trained for this procedure.

The newborn was taken to the procedure room where he was placed under a radiant heat bed at 36°C; a peripheral vein of the back of the hand or the crease of the elbow was punctured with a 20G hypodermic needle and collected in a microcapillary tube that was sealed with plasticine and centrifuged for 6 min at 13,000 rpm. The data was recorded according to the cartilage of the centrifuge.

To guarantee the reliability of the information, postgraduate residents and healthcare residents were trained on hematocrit measurement.

Statistical analysis

Once the information was collected, it was entered into a data matrix of the SPSS ™ 15.0 software (IBM, Chicago, USA). Descriptive statistics based on frequencies and percentages were used for qualitative variables and quantitative measures of central tendency. The variables were previously dichotomized to perform the bivariate analysis, and 2 × 2 contingency tables were used, determining association using the X2 test. *P*-values $P < 0.05$ were considered significant. To measure risk, the using odds radio with a 95% CI was calculated. The results are presented in simple and double-entry tables. For the prevalence report, the confidence interval is used for a 95% proportion.

Results

General characteristics of the mothers of the patients in the sample.

Four-hundred-seventy patients entered the study; 60 patients presented polycythemia at 12.77% (95% CI 12.63–12.91%). The prevailing age of the mothers was 18 to 35 years. Most of them resided in the Andean zone and had secondary education. Among the morbidity presented in the group of mothers, pre-eclampsia, anemia, and urinary tract infection were the most prevalent (2.9% each) (Table 1).

Table 1 Clinical characteristics of the mothers

	Frecuencia (%) n=470
Age 12 to 17 years	46 (9.7%)
Age 18 to 35 years.	387 (82.3%)
Age 36 years and over	37 (7.9%)
Andean Residence	439 (93.4%)
Coastal / Amazon residence	31 (6.6%)
Preterm pregnancy	44 (9.4%)
Term pregnancy	423 (90.0%)
Post term pregnancy	3 (0.6%)
No instruction	28 (6.0%)
Primary education	138 (29.4%)
Secondary education	286 (60.9%)
Higher education	18 (3.8%)
Preterm gestational age	44 (9.4%)
Gestational age at term	423 (90.0%)
Post-term gestational age	3 (0.6%)
Under weight	55 (11.7%)
Normal weight	372 (79.1%)
Overweight	43 (9.1%)
Preeclampsia	14 (2.9%)
Anemia	14 (2.9%)
Urinary tract infection	12 (2.5%)
Diabetes	6 (1.2%)
Obesity	4 (0.8%)
Placental insertion disorders	2 (0.4%)
Eclampsia	1 (0.2%)
Heart disease	1 (0.2%)
HELLP syndrome	1 (0.2%)

HELLP: Hemolysis & elevated liver enzymes & Low platelets

Characteristics of newborns

Half (50%) were eutocic deliveries. The distribution by sex was similar. The delivery was attended in 97% by treating physician and resident, the timely clamping of the umbilical cord and normal nutritional status prevailed (Table 2).

By area of residence, in relation to a height above sea level, Table 3 shows that 93% of maternal lives reside more than 2000 masl and that of the 60 cases of polycythemia, 88% of them (n = 53) belongs to this area. The difference is significant. In 55.5% of the 60 newborns with polycythemia, it was asymptomatic; in the remaining 45.1% (n = 27), there were symptoms. Hypoglycemia and plethora were the most significant (Table 3).

The factors associated with the presence of polycythemia were, in order: low birth weight, maternal pathology including diabetes, toxemia of pregnancy, and is an elderly mother. The association was significant with the first two factors but not with toxemia of pregnancy or being an elderly mother. None of the diabetic mothers had neonates with polycythemia (Table 4).

Discussion

The prevalence of polycythemia found in this research is high relative to the literature; from the medical point of view, altitude refers to hypoxia, due to a decrease in the concentration of oxygen in the atmosphere, in the places located by above 2000 masl [10, 11].

One explanation might be found in the fact that 93% of the mothers of the study population reside in Andean areas at altitudes above 2000 masl. In fact, 88% of neonates with polycythemia belong to this area. Some studies suggest that living at height leads to adaptation [19-22]. Therefore, polycythemia could be a condition found in the neonate. A study carried out in Peru reported an incidence of 9.05% of polycythemia in the neonates of mothers living in areas greater than 3000 masl [21], while at sea level, the reported incidences of polycythemia and hyperviscosity were 1% to 2%, respectively, and at 430 masl it was 5% [22]. In this study, low birth weight, maternal pathology, and being an elderly mother were identified as associated factors, while prematurity behaved as a protective factor.

Low birth weight in the present investigation constitutes a risk factor for polycythemia, which coincides with that previously reported in this institution, where a positive association was found (OR 3.6 IC2.44–5.50 $P< 0.001$) [9]. Theoretically, this finding is justified since an association between lower fetal weight and the intensity of uterine hypoxia has been demonstrated, although there are reports that do not identify low birth weight as a risk factor (OR 499, 95% CI 0.168–1.478; $P= 0.204$) [23], which would suggest that this factor alone is insufficient to cause polycythemia.

Maternal pathology is also identified as a factor associated with polycythemia, with eclampsia (OR 8.2; 95% CI 3.7–17.5), pre-eclampsia (OR 2.8; 95% CI 2.1–3.8), and diabetes (OR 2.8; 95% CI: 2.1–3.7) the most frequently associated factors. It seems that the common factor of arterial hypertension present in the mother is clearly conditioning the presence of intrauterine hypoxia [24-26].

Maternal age has been a controversial factor; in isolated reports, it is a risk factor, and in others, it is not. However, age determines obstetric risk and is associated with pathologies, such as hypertension and diabetes, so it is necessary to carry out new studies to confidently establish this relationship.

Table 2 Clinical characteristics of the study group.

	Frequency (%) n=470
Eutocic delivery	235 (50.0%)
Dystocic delivery	136 (28.9%)
Cesarean surgery	99 (21.1%)
Female	239 (50.9%)
Male	231 (49.1%)
Specialist (health care)	265 (56.4%)
Resident (health care)	193 (41.1%)
Medicine intern (health care)	11 (2.3%)
Timely cord clamping	445 (94.7%)
Delayed cord clamping	25 (5.3%)
Normal Apgar at 1st and 5th minute	470 (100%)
Low weight	46 (9.8%)
Normal weight	416 (88.5%)
High Weight (Macrosomia)	8 (1.7%)
Size from 41 to 49.9 cm	271 (57.7%)
Size 50 to 54 cm	199 (42.3%)
Head circumference 31 to 34.9 cm	279 (59.4%)
Head circumference ≥ 35 cm	191 (40.6%)
Less than 2 hours of life, in measurement	259 (55.1%)
3 to 4 hours of life, in measurement	123 (26.2%)
5 to 6 hours of life, in measurement	88 (18.7%)

Table 3 Polycythemia by area of residence.

Area of residence	W/Pc n=60	Wo/Pc N=410
>2000 masl	53 (88.3%)	385 (93.9%)
<2000 masl	7 (11.7%)	25 (6.15)
Clinical manifestations		
Hypoglycemia	12 (20.0%)	0
Plethora	12 (20.0%)	0
Respiratory distress	1 (1.7%)	1 (0.2%)
Jaundice	1 (1.7%)	0
Irritability	1 (1.7%)	0

masl: meters above sea level. W/Pc: With Polycythemia. Wo/Pc: Without polycythemia.

Table 4 Clinical Characteristics of the Patients-Bivariate Analysis.

Variables	Group W/Pc	Group Wo/Pc	OR	IC		*P*
Low birth weight	15 (25.0%)	33 (8.0%)	3.80	1.9	7.5	<0.001
Maternal pathology (includes diabetes)	13 (21.7%)	39 (9.5%)	2.60	1.3	5.2	0.013
Toxemia of pregnancy	4 (6.7%)	12 (2.9%)	2.34	0.7	7.6	0.134
Maternal Age (elderly vs non-elderly mother)	8 (13.3%)	29 (7.13%)	2.02	0.8	4.6	0.083
Prematurity	2 (3.4%)	42 (10.3%)	0.3	0.07	1.2	0.099

OR: odds ratio. W/Pc: With Polycythemia. Wo/Pc: Without polycythemia.

Regarding gestational age, prematurity was not a statistically significant factor to constitute a protective factor, which agrees with other studies carried out in Paraguay in 2010 reporting that a prevalence in premature infants (22%) with a negative but not statistically significant association (OR 0.8, P = 0.18) [27].

Finally, assuming the limitations inherent to cross-sectional studies, these arguments have the character of approximations without prejudice. They can be incorporated as data that guide future investigations.

Conclusions

Neonatal polycythemia is a highly prevalent disease in Cuenca-Ecuador (12.7%); low birth weight and maternal pathology, including diabetes, were presented as an associated factor.

Abbreviations

OR: Odds ratio. masl: meters above sea level. W/Pc: With Polycythemia. Wo/Pc: Without polycythemia. NPc: Neonatal polycythemia. NB: Newborn.

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Authors´ contributions

TMTB: conceptualization, data curation, formal analysis, fundraising, research, resources, software, writing - original draft.
EROG: supervision, validation, visualization, methodology, project management, writing: review and editing.
JMTP: conceptualization, formal analysis, validation, methodology.
All authors read and approved the final version of the manuscript.

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Availability of data and materials

The data sets generated and / or analyzed during the current study are not publicly available due to the confidentiality of the participants, but are available through the corresponding author upon reasonable academic request.

Ethical statements

This research was approved by the Bioethics Commission of the Faculty of Medical Sciences of the University of Cuenca and the Teaching and Research Commission of the Vicente Corral Moscoso hospital.

Protection of people

The authors declare that the procedures followed were in accordance with the ethical standards of the responsible human experimentation committee and in accordance with the World Medical Association and the Singapore Declaration.

Data confidentiality

The authors declare that they have followed the protocols of their work center on the publication of patient data without identification.

Publication consent

The present study did not involve direct interaction with the participants, so informed consent was not required. The data obtained are generated daily as a result of the registration of the activity of the Maternity service and were used only in the degree work and recorded in a database with an identification code, maintaining confidentiality.

Conflicts of interst

The authors declare not to have any interest conflicts.

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