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Risk Factors for Developmental Dysplasia of the Hip in Newborns from Celaya, Guanajuato, Mexico: A Cross Sectional Study

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Authors' contributions

This work was carried out in collaboration between all authors. Author CML wrote the protocol and wrote the first draft of the manuscript. Author NPR designed the study and statistical analyses of the data. Author GOV supervised the ultrasound diagnosis and clinical data. Author SCDS search literature in electronic databases. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To identify the association between potential risk factors with developmental dysplasia of the hip in neonates.
Study Design: A cross-sectional study.
Place and Duration of the Study: Laboratory of Lifestyle, Division of Health Sciences and Engineering, Campus Celaya Salvatierra, University of Guanajuato Mexico, between June 2014 and February 2015.
Methodology: We include 100 newborns, 36 male and 64 females with age between 4 and 28 days old. Data on birth weight, family history of hip dysplasia, obstetric presentation, mode of delivery, swaddling was obtained. The diagnosis of hip dysplasia hip ultrasonography with Graf technique

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was confirmed. For association Chi squared and p value, for the effect was calculated Odds Ratio and confidence intervals at 95%.
Results: It was found that obstetric presentation and swaddling were associated with developmental dysplasia of the hip ($p < 0.05$) with OR of 5.32 and 4.91 respectively, and the association was confounded by area of residence with OR adjusted 2.94.
Conclusion: It was conclude that the most important risk factors for developmental dysplasia of the hip in this population were obstetric presentation and excessive swaddling.

Keywords: Hip dysplasia; birth weight; presentation; swaddling; ultrasonography.

1. INTRODUCTION

Developmental dysplasia of the hip (DDH) is an abnormality of the hip with pathological changes in the size, shape and cellular organization and is manifested in soft tissue components (instability) or bone (acetabulum) [1]. The spectrum of disorders ranging from a slight incongruity between the joint surfaces of the iliac and femur to the situation where the femoral head is out of the acetabulum, being the most severe [2,3].

The cause of DDH is unknown, invoking ethnic, cultural and genetic factors [3]. Among the risk factors that have shown a strong relationship with DDH they are: family history of DDH, more common in men than in women, obstetric presentation from pelvic birth, presence of other malformations of limbs and the habit of wrapping the newborn and infant in tight manner with the pelvic limbs in extension and adduction [2,3]. Unless, there are other factors related to DDH as maternal age less than 18, greater weight at birth of 4 kg, oligohydramnios [2,3].

These authors mention these risk factors, but with very few references about the association between risk factors and DDH, so it is of interest to identify the association, effect and the impact of risk factors: family history of DDH, obstetric presentation product, high birth weight, birth route, newborn swaddling with ultrasonographic diagnosis of DDH.

They were not found in database searches, recent studies about risk factors for DDH, in the last 20 years and are considered appropriate to investigate what these risk factors in neonates from Mexico.

By identifying potential risk factors, you can intervene in the mothers, so that some of these factors are avoided, and prevent the development of physiological immaturity of hip dislocation. It is considered that an early diagnosis will prevent reaching the dislocation and the risk of being treated surgically, compromising the functionality of the limb.

The aim was to identify the association between some risk factors, like obstetrical presentation, mode of delivery, high birth weight and shape of clothing the infant and its relationship with DDH.

2. MATERIALS AND METHODS

2.1 Ethical Consideration

The protocol was reviewed and approved by Bioethics Committee of Division of Health Sciences and Engineering, Campus Celaya Salvatierra, University of Guanajuato. All parents of newborns signed the consent form.

2.2 Study Design

It was a cross-sectional, prolective, analytical study.

2.3 Place and Duration of the Study

This was a community-based study of infants born in public and private hospitals in Celaya, Mexico, and the procedures were in Laboratory of Lifestyle of Division of Health Sciences and Engineering (DHSE), Campus Celaya Salvatierra (CCS), University of Guanajuato. It was began in June 2014 and conclude in February 2014.

2.4 Universe

Infants born in public and private hospitals in Celaya, Mexico.

2.5 Sampling

Visits were made in public and private hospitals in Celaya, Mexico, and invitations to mothers of newborns who attended outpatient clinic or vaccination services were delivered. The days Monday, Tuesday and Thursday were

randomized visited public hospitals; Wednesdays and Fridays private hospitals.

2.6 Selection of Participants

2.6.1 Inclusion criteria

Newborns, both genders, aged between 4 and 28 days old, whose parents agreed that their children participate by signing the informed consent.

2.6.2 Exclusion criteria

Newborns with teratological or embryo dislocation of the hip.

2.7 Variables

2.7.1 Sociodemographic

Age, gender, area of residence, weight at study entry heights at study entry was measured.

2.7.2 Independent variables

Family history of DDH, is a dichotomy variable; It defined as a first-degree relative (parent or sibling) or second degree (grandparents, uncles or cousins) who suffered DDH. It is measured as yes or not and summarized with frequencies and percentages.

Family affected, is a nominal categorical variable; it is the family that suffered DDH; measured as father, mother, brother, grandparents, uncles or cousins, it is summarized with frequencies and percentages.

Delivery way, is a dichotomy variable; it is the way of delivery of the baby; it measured as vaginal or cesarean and summarized with frequencies and percentages.

Obstetric presentation is a nominal categorical variable; is the anatomical area that delivery first; it measured as cephalic, breech; it summarized with frequencies and percentages.

Birth weight, is a dichotomy variable; the weight is equal to or greater than 3,500 grams at birth; it was obtained from registry of the birth; it measured as present (≥3500 gr) or absent (<3500 gr); it summarized with frequencies and percentages.

Swaddling, is a dichotomy variable; it is how the infant clothing at the time of study entry; verified by the interviewer as loose (allows the mobilization of the pelvic limbs) or excessive swaddling (with immobility of the lower limbs); it summarized with frequencies and percentages.

2.7.3 Dependent variable

Developmental dysplasia of the hip, is a categorical variable; is the anatomical and physiological changes between the components of the hip joint; is measured based on the ultrasonography classification Graf, Graf 1 regular hip, Graf 2-4, developmental dysplasia of the hip [4]; It summarized with frequencies and percentages.

Classification of developmental dysplasia of the hip; it is an ordinal categorical variable; is the anatomical and physiological changes in the components of the hip joint; it measured according to Graf classification; healthy hip - Graf classification I with $\alpha > 60°$ and $\beta < 55°$ angles, functionally immature hip, rated Graf II; α 44° - 59° β 55° -77°; sub dislocation hip or dislocation, rated Graf III and IV; $\alpha < 43°$ and $\beta > 77°$ [4]; it summarized with frequencies and percentages.

2.8 Procedures

Invitations to participate were delivered to mothers of newborns, to go to the lab healthy lifestyle of DHSE, CCS, University of Guanajuato in Celaya, Guanajuato, Mexico. On reaching the laboratory parents were given information sheet for participants on the objectives of the study and voluntary participation. Questions were answered and those who agreed to participate were asked to sign informed consent.

They answered a questionnaire of demographic data and risk factors and the radiologist made ultrasonography of hips with Graf's technique, using a portable ultrasound Honda HS2000® with linear transducer.

2.9 Sample Size

Expecting that 80% of newborns have excessive swaddling and DDH and 44% without excessive swaddling have it, the minimum sample size of 36 newborns with and 36 babies without swaddling with 95% of precision and 80% power (EpiInfo 7.0, 2015, CDC, Atlanta, GA, USA).

2.10 Statistical Analysis

It was use descriptive statistics for all variables in the study. Inferential statistics were used

between the variables considered risk factors and DDH; it was calculate Chi-squared test and p-value, to identify association between risk factors and DDH; Odds Ratio (OR) and confidence intervals at 95% (95% CI) to identify the effect of risk factors on DDH and attributable fraction in exposed, to identify the impact of risk factors on DDH.

A logistic regression between obstetric presentation and DDH, including family inheritance, affected family, mode of delivery, high birth weight, and swadding to check whether the raw OR is different of the OR adjusted, was generated. Likelihood Ratio Test (LRT) was use to demonstrate if the different variables improved the model.

To demonstrate statistical significance, p-value was fixed at 0.05.

Statistical analysis was performed using STATA 13.0 (Stata Corp., College Station, TX, USA).

3. RESULTS AND DISCUSION

The sample consisted of 100 newborns, and it is representative of the population of newborns in Celaya, Guanajuato, because infants of all public and private hospitals in the city were included.

By randomizing day delivery of invitations to participate in public and private hospitals it helps control the presence of known and unknown bias and confounding.

In the sample predominated, females (64%), whose family lived in urban areas (72%) and no family history of DDH (84%) and in case of a family history of DDH was we reported other (cousins , uncles or grandparents) (9%) (Table 1).

In Table 2, quantitative demographic variables are show, which had a mean age of 14.67±7.94 days after birth, birth weight mean of 3.160±.426 kg, height at birth with average 49.76±2.12 cm, weight at study entry with mean 3.539±.586 kg, and height to study entry with mean of 51.88±2.64 cm.

The distribution of the variables considered risk factors for DDH is shown in Table 3. 25% reported high birth weight (≥3.500 kg.); 7% of parents reported that obstetric neonatal presentation was breech; in 49% of infants excessive swaddling with legs in extension and adduction were observed and 59% reported that infants were born by vaginal delivery.

Table 1. Sociodemographic categorical characteristics of the newborns, Celaya, 2014 (n=100)

Variable	n	%
Gender		
Male	36	36.00
Female	64	64.00
Residence area		
Urban	72	72.00
Suburban	19	19.00
Rural	9	9.00
Family background of DDH		
Yes	16	16.00
No	84	84.00
Relative who underwent DDH		
Father	2	2.00
Mother	2	2.00
Sibiling	3	3.00
Other	9	9.00
None	84	84.00

DDH Developmental dysplasia of the hip; Source: Registries from study

Table 2. Sociodemographic quantitative characteristics of the newborns, Celaya, 2014 (n=100)

Variable	Range	Media ± S
Age (days)	4 to 28	14.67±7.94
Birth weight (kg)	1.920 to 4.200	3.160±.427
Height at birth (cm)	44 to 55	49.76±2.12
Weight at interview (kg)	2.270 to 5.100	3.539±.586
Height at interview (cm)	47 to 60	51.88±2.64

S standard deviation; Source: Registries from the study

In Table 4 the results of diagnostic ultrasound is being classified as a binary variable (Graf 1 healthy hips and hips with Graf 2-4 as DDH), as ordinal (Graf 1, 2, 3, and 4) and as nominal (DDH right, left or bilateral). Predominated hips of infants with Graf 1 85.5%, and hips with Graf 2-4 was 14.50%; ultrasonographic diagnosis of altered hips Graf 2 was 13.50% and 1.00% only Graf 3. No cases of complete dislocation were detected. Predominated bilateral cases, followed with impaired left hip.

Table 3. Distribution of study variables, Celaya, 2014 (n=100)

Variable	n	%
High birth weight		
<3.500 kg	75	75.00
≥3.500 kg	25	25.00
Obstetric presentation		
Cephalic	93	93.00
Breech	7	7.00
Excessive swaddling		
No	51	51.00
Yes	49	49.00
Delivery way		
Vaginal	59	59.00
Caesarean section	41	41.00

Source: Registries from study

Table 4. Ultrasonographic diagnosis in newborns, Celaya, 2014 (n=200 hips)

Ultrasonographic diagnosis	n	%
Binary		
Graf 1	171	85.50
Graf 2-4	29	14.50
Ordinal		
Graf 1	171	85.50
Graf 2	27	13.50
Graf 3	2	1.00
Graf 4	0	
Nominal		
Non-affected	171	85.50
Right	4	2.00
Left	5	2.50
Bilateral	10	20.00

Source: Graf technique ultrasounds

Table 5 shows a family history of DDH showed no statistically significant association with ultrasonographic diagnosis of DDH (P=.73); relatives in first or second line with DDH had significant effect (OR = 15.86) but could not identify the association between the two variables because a cell presents 0. Orak et al, [5] reported no effect of birth weight on hip dysplasia in newborns, except that the alpha angle decreased in women with high birth weight.

Breech presentation showed a strong statistical association with DDH (P=.004) having an effect (OR) 15 times higher compared to those who had cephalic presentation and it had an AFe 81.20%; newborns with DDH would have been avoided in 91% if their presentation would have been cephalic and no breech (Table 5). Susuki and Yamamuro, [6] reported that 20% of cases of hip dislocation occurred when the product was in breech presentation against 0.7% in occipital presentation. Mirdad [7] reported in Saudi Arabia, 10% of DDH cases occurred in breech presentation products. Teba et al. [8] reported that 70.59% of infants with developmental dysplasia of the hip, had breech presentation. Kutlu et al. [9] no found association with breech presentation and dislocation of the hip in Turkey. The same fact was reported by Kremli et al. [10] there was an association between breech presentation and DDH.

The path of birth and higher birth weight showed no association with DDC (P= .90 and .85, respectively), but if excessive swaddling showed statistical significance (P=.0004) to great effect (OR = 4.91) even though they were only days they had been wrapped in that. Excessive swaddling showed an AFe= 79.63%, meaning that 78% of infants with DDH would have been avoided if they had not been clothed in excess (Table 5). Noordin [11] mentioned that is most frequently hip dysplasia in children with limbs wrapped in extent and adduction. Kutlu et al. [9] found a significative statistical association between swaddling and dislocation of the hip. Kremli et al. [10] in Saudi Arabian infants found a significative relationship between swaddling and DDH.

A logistic regression model, where DDH was generated as a result variable and obstetric presentation as an independent variable and were including the other variables in the model, finding that crude model between DDH and obstetrical presentation, improved after adjusting for swaddling, and residence was include into the model, obtaining a OR 2.94 (95% CI 0.84 to 10.32) showing that excessive swaddling and residence acted as confounders in the relationship between obstetric presentation and DDH, reducing the OR from 4.23 at 2.94 after adjust by excessive swaddling and residence (Table 6).

Cymet et al. [2] in Mexican Consensus of College of Orthopedics and Traumatology for timely diagnosis of hip dysplasia mentions that the risk factors had higher association with DDH were family history, pelvic presentation and the habit of wrapping the child in tight form with legs in extension and adduction. This was corroborated by the findings in Celaya, where obstetric breech presentation was the risk factor more statistically stronger, followed by excessive swaddling (P=.0004), unlike family history that was not associated with DDH (P=.73).

Table 5. Risk factors and ultrasound diagnosis of developmental dysplasia of the hip, Celaya, 2014 (n=200 hips)

Risk factors	Ultrasound diagnosis		X^2 (df) P-value	OR (95% CI)	AFe %
	DDC n	Non-DDC n			
Family background of DDC			.12	.82	.28
Yes	4	28	(1)	(.26 - 2.53)	
No	25	143	.73		
Family affected			--	15.86	93.69
First line	4	10		(.78 - 324.38)	
Second line	0	18			
Obstetric presentation			8.10	5.32	81.20
Breech	6	8	(1)	(1.76 - 16.13)	
Cephalic	23	163	.004		
Delivery			.02	1.03	0.00
Caesarean section	12	70	(1)	(.47 - 2.26)	
Vaginal	17	101	.90		
Birth weight			.04	.98	0.00
≥3.500 kg	7	33	(1)	(.40 – 2.41)	
<3.500 kg	22	128	.85		
Swaddling			12.46	4.91	79.63
Excessive	23	75	(1)	(1.90 – 12.66)	
Loose	6	96	.0004		

DDH Developmental dysplasia of the hip df degree freedom OR Odds Ratio 95%CI 95% confidence interval AFe Attributable fraction in exposed; Source: Measures of the study and ultrasounds

Table 6. Logistic regression model, Celaya, 2014

Variables in the model	OR	95%CI	LRT	P-value
1 Obstetric presentation and DDC	4.23	1.36 – 13.13	5.64	.02
1 + family affected	4.53	1.43 – 14.32	2.70	.10
1 + high birth weight	4.14	1.33 – 12.88	.24	.62
1 + delivery way	4.25	1.37 – 13.21	.16	.69
1 + swaddling	3.42	1.05 - 11.12	11.16	.0008
1 + Age	3.46	1.06 – 11.26	.18	.67
1 + residence	3.75	1.15 – 12.27	1.85	.17
1 + swaddling + residence	2.94	.84 – 10.32	4.52	.03

DDC Developmental dysplasia of the hip, OR Odds Ratio 95%CI 95% confidence interval; LRT: Likelihood Ratio Test; Source: Analysis of data from study

Cymet et al. [2] also mentioned the birth weight of 4 kg or more as a risk factor for DDH. The results in Celaya study, showed no association between birth weight equal to or greater than 3.500 kg) and DDH (P=.85).

4. CONCLUSION

It is confirmed that some of the risk factors considered having strong association DDC (obstetric presentation and swaddling) while others such as high birth weight, family history that no shown it in this sample.

It would be important to monitor infants with physiological immaturity to corroborate if they develop subluxation or dislocation.

CONSENT

All authors declare that 'written informed consent was obtained from the parent's newborns.

ETHICAL APPROVAL

The protocol was approving by Bioethics Committee from Division of Health Sciences and Engineering with the registry: CIDSIC-1391310 October 30th, 2013.

All authors hereby declare that all procedures have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical

standards laid down in the 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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