

Original Article

Incidence of Developmental Dysplasia of the hip (DDH) in Helena Rehabilitation Center in Erbil city, Iraq

Rebaz Abubakir Mohammad^{1*}, Kawes Omer Hamad², Yusra Almas³, Marof Tassen Hassan⁴

¹ Raparin Pediatric Teaching Hospital, Erbil, KRG, Iraq

² Department of Pediatrics, College of Medicine, Hawler Medical University, Erbil, KRG, Iraq

³ Helena Rehabilitation Center, Erbil, KRG, Iraq

⁴ Department of Community Medicine, College of Medicine, Hawler Medical University, Erbil, KRG, Iraq

*Corresponding author: rebazmamundi@gmail.com

Abstract

Background: Developmental dysplasia of the hip (DDH) comprises a spectrum of pathology in the development of the immature hip joint ranging from mild dysplasias to complete dislocations. Epidemiological data about developmental dysplasia of the hip varies culturally and geographically. The aim of the study was to report on the sonographic incidence of developmental dysplasia of the hip in Erbil city.

Methods: A retrospective descriptive study was conducted at the Helena Rehabilitation Center in Erbil City. All infants who underwent ultrasound examination for developmental dysplasia of the hip between January 2023 to July 2023 were included. Ultrasound screening was performed using the Graf method. Bivariate and multivariable logistic regression methods were used, and independent variables were determined based on adjusted odds ratios with 95% confidence intervals and a p-value of less than 0.05.

Results: Among 533 infants, 174 were diagnosed with developmental dysplasia of the hip, including 165 with hip dysplasia and 9 with hip dislocation. The incidence of hip dysplasia in Erbil was 0.5 per 100 for hip dysplasia (95% CI, 0.4-0.6) and 0.3 per 1000 for hip dislocation (95% CI, 0.2-0.4). The incidence of hip dysplasia at Helena center was 30.9% while hip dislocation was 1.7%. Developmental dysplasia of the hip was significantly associated with a positive family history (AOR: 1.80, 95% CI: 1.21-2.66), female gender (AOR: 2.32, 95% CI: 1.58-3.42) and swaddling (AOR: 2.01, 95% CI: 1.37-2.94).

Citation : Mohammad R. A., Hamad K. O., Almas Y., Hassan M. T., Incidence of Developmental Dysplasia of the hip (DDH) in Helena Rehabilitation Center in Erbil city, Iraq. *Ethiop J Pediatr Child Health*. 2025;20 (1): 45-54 **Submission date:** 29 September 2025 **Accepted:** 05 April 2025 **Published:** 01 May 2025

Conclusion: *The incidence of developmental dysplasia of the hip in Erbil is lower than that reported in global literature. Swaddling contributes to approximately half of all developmental dysplasia of the hip cases and most hip dislocations. Female infants and those with a positive family history had a twofold increased risk of developmental dysplasia. Public health initiatives should focus on educating parents about the risks of tight swaddling.*

Keywords: *Developmental dysplasia, Incidence, Risk factors, Swaddling*

Introduction

Developmental dysplasia of the hip (DDH) comprises a spectrum of pathology in the development of the immature hip joint ranging from mild dysplasias to complete dislocations (1). While many newborn screening studies indicate that hip instability can be identified in approximately 1 in 100 to 1 in 250 infants, the occurrence of fully dislocated or dislocatable hips is considerably less frequent, with an incidence of 1-1.5 per 1000 live births. The incidence of DDH varies significantly across different geographical and racial groups, which may be influenced by environmental factors rather than solely genetic predisposition (1, 2).

The instability of the hip joint results from increased joint laxity which is likely the result of a combination of hormonal, mechanical, and genetic factors (1, 2). Approximately 12-33% of individuals with DDH have a positive family history of the condition, indicating a potential genetic influence. Moreover, DDH is more prevalent in female patients (around 80%), which is thought to be due to the increased susceptibility of female fetuses to maternal hormones like relaxin, which can affect ligament laxity. Even though only 2-3% of babies

are born in breech presentation, the incidence of DDH in such cases ranges from 16-25%. Understanding these risk factors is crucial for the early identification and management of DDH (1). Factors leading to a restricted intrauterine space, resulting in less room for normal fetal movement, for example first pregnancy can be linked to DDH (1). The strong association between DDH and torticollis (1, 2), supports the idea that the crowding effect plays a role in its development. Notably, the left hip is the most commonly affected, often because it's pushed into adduction by the mother's sacrum (1).

Swaddling has been practiced for centuries as a method to soothe infants and when done safely research has proven its benefit for infant colic(3). However, tight and unsafe swaddling which is defined as wrapping babies tightly with their hips extended and adducted has been identified as a significant risk factor for hip dysplasia. Studies in populations where infants are traditionally swaddled in a manner that restricts them from naturally bringing their hips into a flexed position (known as the "M" position) have shown negative impacts on hip development(1, 3, 4).

Early diagnosis of DDH can prevent long-term complications and complex treatments. Ultrasonography is the diagnostic modality of choice for screening DDH ideally for infants aged six weeks to six months. Ultrasonography earlier than six weeks may yield false positives and later than six months ultrasound will no longer be useful because of the ossification of the femoral head(1).

Our aim was to determine the incidence of DDH in Erbil City, where epidemiological data is lacking. By doing so, we aim to contribute to the global understanding of DDH epidemiology and provide a foundation for future research. In addition, we analyzed the association between DDH and key risk factors, particularly swaddling which remains a traditional and common practice in Erbil City, Iraq. Our findings aim to raise awareness about the risks of unsafe swaddling and contribute to public health education.

Methods

Study setting, period and design

A retrospective descriptive study was conducted at the Helena Rehabilitation Center, a pediatric orthopedic center specializing in DDH diagnosis and management in Erbil, Iraq. Helena center is the only recognized public center in Erbil for pediatric orthopedics and rehabilitation where almost all DDH cases are diagnosed and managed. Some cases are managed at private sector. Therefore, in this study it is assumed that almost all cases of DDH are presented to Helena center. The study was per-

formed from January 2023 to July 2023.

Population and eligibility criteria

The study population comprised infants aged 6 weeks to 6 months. The center's policy restricts ultrasound screening to this age group to minimize false positives and account for femoral head ossification beyond 6 months. Data were collected from medical records of all infants screened during the study period. Subjects were referred from both public and private outpatients of Orthopedics and Pediatrics in Erbil city. Referrals originated from both public and private healthcare facilities, with most cases referred from Helena Rehabilitation Center, Raparin Pediatric Teaching Hospital and the Neonatal Care Unit of Erbil Obstetrics and Maternity Hospital.

Sample size and sampling technique

A total of 533 infants who underwent DDH screening at Helena Rehabilitation Center between January 2023 and July 2023 were included in the study.

Data collection

Data about clinical examination was not available so physical examination is not included in this study. Data was collected from the record about the infants' age, sex, parity, presentation, family history of DDH (first- and second-degree relatives), torticollis and club foot and traditional swaddling. Every infant had been sonographically screened for both hips by an experienced radiologist using ultrasound GE versana premier machine, linear probe L6-12 using Graf method at the ultrasound unit of the

center. Graf method originally described by Reinhard Graf in 1980(5) in which the hips are examined for DDH in coronal section at rest then alpha and beta angles are measured. Alpha

(α) angle (measures osseous convexity) normally $>60^\circ$. Beta (β) angle (measures the acetabulum's cartilaginous growth) normally $<55^\circ$, Table (1).

Table (1): Graf classification (5)

Graf type	α angle	β angle	Description
Type I	$\geq 60^\circ$	$< 55^\circ$	Normal mature hip joint
Type IIa	$50^\circ - 59^\circ$	$55^\circ - 77^\circ$	Physiological immaturity at < 3 months of age
Type IIb	$50^\circ - 59^\circ$	$55^\circ - 77^\circ$	Delayed maturity at > 3 months of age
Type IIc	$43^\circ - 49^\circ$	$< 77^\circ$	Dysplastic hip but the cartilaginous roof (labrum) still covering the head
Type IId	$43^\circ - 49^\circ$	$> 77^\circ$	Similar to type IIc but the labrum is everted cranially
Type III	$< 43^\circ$	$> 77^\circ$	Dislocated femoral head with shallow acetabulum and everted labrum (pressed upwards)
Type IV	unmeasurable	unmeasurable	Total dislocation of femoral head with marked displacement and inversion of labrum

Operational definition

In our study type 1 is considered normal, type 2 with all its subtypes is regarded as hip dysplasia and type 3 along with type 4 were regarded as hip dislocation.

Data analysis

Microsoft Office Excel version 21 and Statistical Package for the Social Sciences (SPSS) version 27 were used to organize and clean the data. Chi-Square Test of associations and Fisher's Exact Test were used to compare proportion. A p-value of ≤ 0.05 is considered statistically significant. Bivariable analysis was used to study the association. Variables that had a p-value of less than 0.25 in the bivariable analysis were included in the multivariable logistic

regression analysis. A confidence interval of 95% is calculated for the incidence.

Results

Among the total 533 infants, 174 (32.6%) were diagnosed with DDH. Regarding the distribution of affected hips, 72 (13.5%) had involvement of the right hip, 47 (8.8%) had involvement of the left hip, and 55 (10.3%) had involvement of both hips. The classification of DDH based on the Graf classification system revealed that the majority of infants were classified as Type 1 (67.4%). Type 2a, 2b, 2c, 2d, 3, and 4 accounted for 16.9%, 10.7%, 2.8%, 0.5%, 1.3%, and 0.4% of cases, respectively, Table (2).

Table (2): Ultrasound diagnosis of DDH among the infants

Variables	Categories	Frequency	Percentage
Ultrasound diagnosis	DDH	174	32.6
	Normal	359	67.4
Affected hips	Nil	359	67.4
	Right hip	72	13.5
	Left hip	47	8.8
	Both hips	55	10.3
Graf type	Type 1	359	67.4
	Type 2a	90	16.9
	Type 2b	57	10.7
	Type 2c	15	2.8
	Type 2d	3	0.5
	Type 3	7	1.3
Total	Type 4	2	0.4
		533	100

The incidence of hip dysplasia at Helena center was 30.9% and 1.7% for hip dislocation. The incidence of DDH in Erbil city according to our study was 0.5 per 100 for hip dysplasia (95% CI, 0.4-0.6) and 0.3 per 1000 for hip dislocation (95% CI, 0.2-0.4). This incidence was

calculated based on the number of newborns in Erbil in 2022 which was 68,236. This data was obtained from KRSO (Kurdistan Region Statistics Office). Data for 2023 was not available, Table (3).

Table (3): Incidence of DDH in Helena center and in Erbil City.

Variable	DDH type	Helena center	Erbil City
Incidence of DDH	Hip dysplasia	30.9%	0.5 per 100
	Hip dislocation	1.7%	0.3 per 1000

By using Chi-Square Test of associations and Fisher's Exact Test there is statistically significant association between DDH and each of family history, female gender and swaddling, p values were ≤ 0.05 , ≤ 0.001 and ≤ 0.001 respec-

tively, while there is no statistically significant association between DDH and each of breech, torticollis, club foot and firstborn child, p values were ≤ 0.4 , ≤ 0.6 , ≤ 0.9 and ≤ 0.2 respectively, Table (4).

Table (4): Association of DDH with certain variables

Variable	Categories	DDH	Normal	P value
Family history	Positive	74 (42.5%)	115 (32%)	≤0.05
	Negative	100 (57.5%)	244 (68%)	
Breech	Yes	46 (26.4%)	83 (23.1%)	≤0.4
	No	128 (73.6%)	276 (76.9%)	
Torticollis	Yes	2 (1.1%)	6 (1.7%)	≤0.6
	No	172 (98.9%)	353 (98.3%)	
Club foot	Yes	1 (0.6%)	2 (0.6%)	≤0.9
	No	173 (99.4%)	357 (99.4%)	
Gender	Female	114 (65.5%)	167 (46.5%)	≤0.001
	Male	60 (34.5%)	192 (53.5%)	
First born	Yes	62 (35.6%)	110 (30.6%)	≤0.2
	No	112 (64.4%)	249 (69.4%)	
Swaddling	Yes	87 (50%)	122 (34%)	≤0.001
	No	87 (50%)	237 (66%)	
Total		174 (100%)	359 (100%)	

Variables that had a p-value of less than 0.25 in the bivariable analysis were included in the multivariable analysis. In bivariable logistic regression, factors such as female gender, family history, swaddling and firstborn were found to be significantly associated with DDH. In multivariable analysis these factors still remained statistically significantly associated with DDH. Accordingly, females are twice likely to have DDH compared to males (AOR; 2.32, 95% CI: 1.58-3.42). Infants who have positive family history of DDH (1st and/

or 2nd degree) are almost twice likely to have DDH than those who have negative family history of DDH (AOR; 1.80, 95% CI: 1.21-2.66). Infants who have been swaddled traditionally unsafely are two times more likely to have DDH than those who have not been swaddled or swaddled but safely (AOR; 2.01, 95% CI: 1.37-2.94). Infants who are firstborn are slightly more at risk to have DDH than those who are born to multiparous mothers (AOR; 1.34, 95% CI: 0.9-2.00) (Table 5).

Table (5): Bivariable and multivariable logistic analysis of factors associated with DDH

Variables		DDH	Normal	Crude OR (95% CI)	Adjusted OR (95% CI)
Gender	Female	114 (65.5%)	167 (46.5%)	2.18(1.50-3.17)	2.32(1.58-3.42) **
	Male	60 (34.5%)	192 (53.5%)	1	1
Family history	Positive	74 (42.5%)	115 (32%)	1.57(1.08-2.28)	1.80(1.21-2.66) *
	Negative	100 (57.5%)	244 (68%)	1	1
Swaddling	Yes	87 (50%)	122 (34%)	1.94(1.34-2.80)	2.01(1.37-2.94) **
	No	87 (50%)	237 (66%)	1	1
Firstborn	Yes	62 (35.6%)	110 (30.6%)	1.25(0.85-1.83)	1.34(0.9-2.00)
	No	112 (64.4%)	249 (69.4%)	1	1

Key: *p-value \leq 0.05, **p-value \leq 0.001, OR= Odds Ratio

Discussion

In our study the incidence of DDH in Erbil city was calculated to be 0.5 per 100 for hip dysplasia and 0.3 per 1000 for hip dislocation. These results are lower than that found in the literature which is globally about 1 per 100 for hip dysplasia and 1 per 1000 for hip dislocation(1). This can be explained by the possibility of some of the infants being referred to private hospitals instead of Helena center, which is the only recognized public center to care for DDH. Therefore, the incidence might be underestimated. However, our incidence for hip dysplasia were comparable to that of Studer et al, Kural et al, Wilf-Miron et al, Wenger et al and Phelan et al which were 0.6, 0.5, 0.5, 0.4 and 0.4 per 100 respectively(6-10). Our incidence for hip dislocation were comparable with that of Moosa et al, Tyagi et al, Talbot et al, Giannakopoulou et al and Woodacre et al which were 0.3, 0.3, 0.3, 0.3 and 0.4 per 1000 respectively(11-15). Our findings were high when compared with that in Ethiopia and other

Sub-Saharan countries. In Ethiopia incidence of DDH is 0.15% which may be attributed to the lack of facilities or limited access to healthcare service. Another reason might be in Ethiopia and other Sub-Saharan countries mothers back carry their babies in the first two years of life in a position similar to that of the Pavlic harness(16). In contrast in Erbil the high incidence when compared with Ethiopia seems to be due to that mothers traditionally swaddle their babies unsafely in a position that makes them vulnerable to develop DDH(1).

Gender distribution among DDH cases were 65.5% for females and 34.5% for males with female to male ratio 1.9:1 which was almost consistent with a study done by Alrosan et al in which 62% of DDH patients were female and 38% were male with female to male ratio 2:1(17).

The most common hip affected in our study was right hip 41.4% followed by both hips 31.6% which is not consistent with the results of the literature in which left hip is the most

commonly affected followed by both hips(18). Nevertheless, another study done by Pulik et al revealed right hip as most frequently involved (19).

The most common type of DDH was type 1 67.4% followed by type 2a 16.9%, type 2b 10.7%, type 2c 2.8%, type 3 1.3%, type 2d 0.5% and type 4 as the least common type 0.4% which was close to the result of the study conducted by Pulik et al with regards to commonest types(19).

Generally accepted risk factors for DDH by most authors include family history, breech and torticollis(1). In our study family history (first and/or second-degree relatives) had statistically significant association with DDH. However, no such association was found between either of breech, torticollis and club foot with DDH. There is also no statistically significant association between first born and DDH. Swaddling nowadays is identified by many authors as an independent risk factor for DDH (1, 3, 4). Our study revealed highly statistically significant association between swaddling and DDH. According to our study in Erbil city swaddling is responsible for about half of the cases of DDH in general and about most of the cases of hip dislocation in particular. One limitation of our study is that the sample may not fully represent the entire population as some patients seek care at private clinics rather than visiting Helena Center. We suggest that future studies include a broader population base, incorporating data from private healthcare facilities to improve generalizability. Another limi-

tation is the lack of longitudinal follow-up, which prevented us from tracking the long-term outcomes particularly those with physiological changes that may resolve spontaneously with observation. As a result, the reported incidence may not fully capture the true burden of the condition. We recommend future follow-up studies to assess treatment outcomes and long-term complications more accurately.

Conclusions

Incidence of developmental dysplasia of the hip in Erbil is low compared with that in the literature which might be underestimated. According to our study swaddling is responsible for about half of the cases of DDH in general and about most of the cases of hip dislocation in particular. Therefore, public awareness should be done to educate people about the danger of tight swaddling. We recommend that a larger study to be done with frequent follow up for at least one year to have a more accurate epidemiology of DDH.

Ethical Considerations

The Kurdistan Higher Council of Medical Specialties (KHCMS)/research protocol ethics committee granted approval of the study.

Conflicts of interests

The authors declare that they have no conflicts of interests.

Authors contribution

KH conceived the idea of the study, developed the proposal, supervised, reviewed the work and was involved with the analysis, interpretation and writing. RM, KH, YA and MH

contributed to the conceptualization of the study, methodology, writing final draft, writing and reviewing of the manuscript.

Funding: No funding

Reference

1. Sankar WN, Horn BD, Winell JJ, Wells L, Developmental Dysplasia of the Hip, In: Kliegman RM, St. Geme III JW, Blum NJ, Taskar RC, Wilson KM, Schuh AM, et al. Nelson Textbook Of Pediatrics. 22nd ed. United States: Elsevier; 2024:4232-4236.
2. Loder RT, Skopelja EN. The epidemiology and demographics of hip dysplasia. *ISRN Orthop*. 2011 Oct 10;2011:238607.
3. Van Sleuwen BE, Engelberts AC, Boere-Boonekamp MM, Kuis W, Schulpen TW, L'Hoir MP. Swaddling: a systematic review. *Pediatrics*. 2007 Oct;120(4):e1097-106. doi: 10.1542/peds.2006-2083. PMID: 17908730.
4. Price, Charles T. "Swaddling and hip dysplasia: new observations: commentary on an article by Enbo Wang, MD, PhD, et al.: "Does swaddling influence developmental dysplasia of the hip? An experimental study of the traditional straight-leg swaddling model in neonatal rats"." *The Journal of bone and joint surgery. American volume* vol. 94,12 (2012): e92. doi:10.2106/JBJS.L.00297
5. Gulati V, Eseonu K, Sayani J, Ismail N, Uzoigwe C, Choudhury MZ, Gulati P, Aqil A, Tibrewal S. Developmental dysplasia of the hip in the newborn: A systematic review. *World J Orthop*. 2013 Apr 18;4(2):32-41.
6. Studer K, Williams N, Antoniou G, Gibson C, Scott H, Scheil WK, et al. Increase in late diagnosed developmental dysplasia of the hip in South Australia: risk factors, proposed solutions. *Med J Aust*. 2016 Apr 4;204(6):240.
7. Kural B, Devocioğlu Karapınar E, Yılmazbaş P, Eren T, Gökçay G. Risk Factor assessment and a ten-year experience of DDH screening in a well-child population. *Biomed Res Int*. 2019 Aug 4;2019:7213681.
8. Wilf-Miron R, Kuint J, Peled R, Cohen A, Porath A. Utilization of ultrasonography to detect developmental dysplasia of the hip: when reality turns selective screening into universal use. *BMC Pediatr*. 2017;17(1):136.
9. Wenger D, Düppe H, Tiderius CJ. Acetabular dysplasia at the age of 1 year in children with neonatal instability of the hip. *Acta Orthop*. 2013;84(5):483-488.
10. Phelan N, Thoren J, Fox C, O'Daly BJ, O'Beirne J. Developmental dysplasia of the hip: incidence and treatment outcomes in the Southeast of Ireland. *Ir J Med Sci*. 2015;184(2):411-415.
11. Moosa NK, Kumar PT, Mahmoodi SM. Incidence of developmental dysplasia of the hip in Dubai. *Saudi Med J*. 2009;30(7):952-955.

12. Tyagi R, Zgoda MR, Short R. Targeted screening of hip dysplasia in newborns: experience at a district general hospital in Scotland. *Orthop Rev (Pavia)*. 2016;8(3):6640.
13. Talbot C, Adam J, Paton R. Late presentation of developmental dysplasia of the hip : a 15-year observational study. *Bone Joint J*. 2017;99-B(9):1250-1255.
14. Giannakopoulou C, Aligizakis A, Korakaki E, Velivasakis E, Hatzidaki E, Manoura A, et al. Neonatal screening for developmental dysplasia of the hip on the maternity wards in Crete, Greece. correlation to risk factors. *Clin Exp Obstet Gynecol*. 2002;29(2):148-52.
15. Woodacre T, Ball T, Cox P. Epidemiology of developmental dysplasia of the hip within the UK: refining the risk factors. *J Child Orthop*. 2016;10(6):633-642.
16. Graham, S.M.; Manara, J.; Chokocho, L.; Harrison, W.J. Back-carrying infants to prevent developmental hip dysplasia and its sequelae: Is a new public health initiative needed? *J. Pediatr. Orthop*. 2015, 35, 57–61.
17. Alrosan FM, Alibrahem FS, Almaitah AA, Shari NF, A-Baryhie NH. Incidence of Developmental Dysplasia of the Hip among Jordanian Population. *J Royal Medical Services*. August 2023;30(2):56-62.
18. Chen X, Liu J, Xue M, Zou C, Lu J, Wang X, et al. Risk factors of developmental dysplasia of the hip in infants: A meta-analysis based on cohort studies. *Orthop Traumatol Surg Res*. 2024;110(4):103836.
19. Pulik Ł, Płoszka K, Romaniuk K, Sibilska A, Jedynek A, Tołowinski I, et al. Impact of multiple factors on the incidence of developmental dysplasia of the hip: risk assessment tool. *Medicina*. 2022;58(11):1158.