BMJ Open

Screening, diagnosis, treatment and outcomes of developmental dysplasia of the hip in Brazilian population: a scoping review

Patrícia Eduarda Conrado Martins Rocha Jaleca,[1] Daniel Frank Liggio ,[2] Sana Arora,[3] Sheila Lam,[3] Emily Schaeffer ,[4] Patricia Moreno Grangeiro [5]

To cite: Jaleca PECMR, Liggio DF, Arora S, *et al*. Screening, diagnosis, treatment and outcomes of developmental dysplasia of the hip in Brazilian population: a scoping review. *BMJ Open* 2025;**15**:e094660. doi:10.1136/bmjopen-2024-094660

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-094660).

Received 06 October 2024
Accepted 24 December 2024

Check for updates

© Author(s) (or their employer(s)) 2025. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ Group.

For numbered affiliations see end of article.

Correspondence to
Dr Patricia Moreno Grangeiro; patricia.moreno@hc.fm.usp.br

ABSTRACT

Objective This study aims to map the literature on screening, diagnosis, treatment and outcomes of developmental dysplasia of the hip (DDH) in the Brazilian population aged 0–18 years, to describe regional variations in its presentation and management.

Design Scoping review.

Data sources PubMed/MEDLINE, Web of Science, Scopus, "Biblioteca Virtual em Saúde" and "Biblioteca Digital Brasileira de Teses e Dissertações". The journals, Revista Brasileira Ortopedia and Acta Ortopédica Brasileira, were manually searched for non-indexed issues. Databases were searched from their inception to February 2024.

Eligibility criteria This scoping review included studies on Brazilian patients aged 0–18 years diagnosed with or being assessed for DDH. No language or date restrictions were applied.

Data extraction and synthesis Studies were assessed based on title, authors, publication year, study design, sample size, level of evidence, region of Brazil and healthcare setting (public or private). The articles were then analysed across four categories: screening, diagnosis, treatment and outcomes.

Results 52 studies, published between 1951 and 2023, were included. Reported prevalence rates ranged from 0.75 to 56.4 cases per 1000 children. No study examined the effectiveness of specific screening programmes or compared their outcomes. The most common diagnostic methods were the Ortolani manoeuvre and ultrasonography using the Graf method. Of the 27 articles on treatment, 17 focused exclusively on surgical interventions, with the Salter osteotomy being the most frequent procedure.

Conclusions There should be a greater focus on understanding the prevalence of DDH in Brazil, the availability of ultrasound devices and trained operators, and the follow-up of conservative treatments. More information on DDH in Brazil is essential for designing and implementing effective screening and treatment programmes. Future research should be done to understand the prevalence of the disease, optimal forms of screening and early treatment.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is the first scoping review to study developmental dysplasia of the hip specifically in the Brazilian population.
⇒ A rigorous framework for designing and conducting a scoping review developed by the Joanna Briggs Institute was applied in the production of this study.
⇒ This scoping review may not be able to identify all studies in grey literature despite attempts to be as comprehensive as possible.

INTRODUCTION

Developmental dysplasia of the hip (DDH) includes a spectrum of hip findings at birth or infancy, including congruent hips with dysplastic acetabulum, unstable hips or frankly dislocated hips.[1] DDH ccan be associated with syndromes but is otherwise a condition affecting otherwise healthy children, with an incidence of 1%–2%, though this may vary depending on the population and screening methods used.[2 3] The general treatment goal for DDH is to achieve and maintain a concentric reduction of the femoral head in the acetabulum.

Diagnosing DDH is challenging, as it may not be noticeable and is typically asymptomatic at birth; therefore, it may go undetected, particularly in areas where screening strategies are not implemented. Diagnosis may involve either a clinical exam, imaging or both. Ultrasonography has been the most common choice for imaging in the age group up to 6 months of age.[4–7] The availability and reliability of ultrasonography in areas with limited resources are unknown.[8–10]

Screening for DDH includes programmes that use universal or selective ultrasonography in the newborn population. Controversy exists regarding the potential for overdiagnosis with universal screening protocols.[4 11]

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

There is a lower incidence of delayed diagnosis in countries with wide availability of ultrasound.[12] In developing countries, ultrasound examinations continue to be challenging because of restricted access to ultrasound devices and the lack of experienced or trained professionals to perform the examination.[13 14]

Failure to make an early and timely diagnosis hinders the possibility of non-surgical treatment.[13 15 16] When DDH is diagnosed later, there is a greater likelihood of the need for increasingly extensive corrective surgeries, which can lead to poorer outcomes including pain, disability and the development of osteoarthritis. Underserved regions may treat their children at a later age and consequently have more sequelae. These invasive and complicated surgeries become necessary due to the progression of untreated DDH, which can include gait dysfunction after walking age as well as long-term symptoms including hip and knee pain and degenerative joint changes.[17]

Brazil is a country of continental dimensions, divided geographically into five regions with major socioeconomic differences between them and within themselves. These differences are shown in the divergent health resources available in each area and the healthcare provided to the population. Approximately 75% of the Brazilian population relies exclusively on the Brazilian Unified Health System (SUS), which is the largest public and universal healthcare system in the world.[18]

This scoping review aims to map the available literature related to epidemiology, screening, diagnosis, treatment and outcomes of DDH in the Brazilian population to provide an overview of this condition and to describe regional variations in presentation and management across the country. Moreover, knowledge of regional differences in the availability of screening tests is pivotal for advising and implementing guidelines for the screening and diagnosis of DDH in Brazil. This can provide valuable information to public authorities for developing policies regarding DDH. A preliminary search of PROSPERO, MEDLINE and Joanna Briggs Institute (JBI) Evidence Synthesis was conducted and no current or in-progress scoping reviews or systematic reviews on the topic were identified.

Review question

This scoping review will explore the available literature on DDH in the Brazilian population to investigate variations in screening, diagnosis, treatment and outcomes across the country.

METHODS

A scoping review is suitable for summarising and disseminating research findings and identifying research gaps in existing literature.[19] Our study was conducted in accordance with the JBI methodology for scoping reviews[20] and in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews.[21] This review was conducted in accordance with an a prior protocol published on BMJ Open (https://doi.org/10.1136/bmjopen-2024-085403). This review has been registered in the Open Science Framework DOI Registration (https://doi.org/10.17605/OSF.IO/V3AYH).

Inclusion criteria

We considered studies which included paediatric patients aged 0–18 years, according to the Brazilian Society of Pediatric Orthopedics definition of paediatric age, with a diagnosis of DDH or who were being evaluated for a diagnosis of DDH.

Exclusion criteria

Studies which included patients over 18 years or those addressing DDH as part of other conditions were excluded.

Context

This review considered published and unpublished studies that were related to the Brazilian population through the explicit study of Brazilian patients.

Types of sources

This scoping review considered both experimental and quasi-experimental study designs including randomised controlled trials, non-randomised controlled trials, before-and-after studies and interrupted time-series studies. In addition, analytical observational studies including prospective and retrospective cohort, case–control and analytical cross-sectional studies were considered for inclusion. This review also considered qualitative data and descriptive observational study designs including case series with more than 10 patients and descriptive cross-sectional studies. In addition, systematic reviews which met the inclusion criteria were considered, depending on the research question. Grey literature, such as unpublished studies and government data, was included in this scoping review, as well as text and opinion papers.

Search strategy

The search strategy aimed to locate both published and unpublished studies, reviews, and text and opinion papers. An initial limited search of the MEDLINE/PubMed, Web of Science, Scopus, “Biblioteca Virtual em Saúde,” “Biblioteca Digital Brasileira de Teses e Dissertações”, “Revista Brasileira Ortopedia” and “Acta Ortopédica Brasileira” was performed to identify articles on the question presented in this paper. The text words contained in the titles and abstracts of relevant articles, and the index terms used to describe the articles were used to develop a full search strategy. The search strategy, which is presented in full in online supplemental Appendix I, included keywords and their translation to Portuguese based on DeCS translation for MeSH terms. Databases were searched from their inception to 8 February 2024. The reference list of all included sources of evidence was screened for additional studies.

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

Studies published in any language were included. Studies published from database inception to the date of the search were included to ensure the broadest exploration of the literature possible. The databases searched included "Biblioteca virtual em saúde", Scientific Electronic Library Online, Web of Science, Scopus and PubMed/MEDLINE. Sources of unpublished studies/grey literature were searched in "Biblioteca Digital Brasileira de Teses e Dissertações". The prominent Brazilian orthopaedic journals, Revista Brasileira Ortopedia and Acta Ortopédica Brasileira, were manually searched for articles for all years of publication previous to indexation in the searched databases.

Study/source of evidence selection

Following the search, all identified citations were organised and uploaded to Rayyan (Rayyan, Massachusetts, USA), a web-based systematic review tool designed to streamline the process of managing and synthesising research literature and duplicates removed. Articles were then analysed by two independent reviewers to assess them against the inclusion criteria for the review. Potentially relevant sources were retrieved in full and their citation details were imported into a data abstraction table developed by the research team. The full texts of the selected citations were assessed in detail against the inclusion criteria by two or more independent reviewers. Articles which did not meet the inclusion criteria were excluded, and reasons for their exclusion are provided in online supplemental Appendix II. Any disagreements between reviewers at each stage of the selection process were resolved through discussion or with a third reviewer.

Data extraction

Data were extracted from the articles included in the scoping review by two independent reviewers, using an online spreadsheet according to the tool described in online supplemental Appendix III. The following data points were collected from each article: (1) study title; (2) authors; (3) publication year; (4) study design; (5) number of patients; (6) level of evidence study using the Oxford Centre for Evidence-Based Medicine level of evidence; (7) region of Brazil from where the population was the object of the study and (8) Healthcare setting of the study: public or private. Then, the authors analysed all articles responding to questions related to four categories according to the objectives of this study: screening, diagnosis, treatment and outcomes. Relevant topics according to each category were discussed as follows:

Screening: Fetal presentation for birth; sex; other conditions (twin pregnancy, metatarsus adductus, congenital torticollis), family history of DDH; clinical examination at birth and considered risk factors and criteria for indicating selective ultrasonography.

Diagnosis: Age; how the diagnosis was assessed; the incidence of the condition in the population of the region of the study; usage of ultrasound, X-ray or a combination for diagnosis; clinical examination by a general practitioner; clinical examination by a specialist; late diagnosed DDH and prolonged postnatal positioning, such as swaddling.

Treatment: Age at which treatment began; time between diagnosis and treatment; treatment strategies (conservative or surgical); type of non-surgical treatment; incidence of closed reduction and incidence of open reduction.

Outcomes: Incidence of successful closed reduction; occurrence of other adverse events arising from prereduction hip traction; incidence of residual subluxation postoperatively; incidence of avascular necrosis (AVN) of the femoral head and/or neck postreduction; incidence of acetabular dysplasia and incidence of secondary procedures.

Data analysis and presentation

The data are presented in graphical and tabular form. These visual representations of the data are provided to illustrate the most significant findings in a manner which is readily accessible. A narrative summary accompanies the figures to better illustrate how the collected data relates to the research question.

RESULTS

2007 studies were identified through our initial search. 1955 were excluded such that 52 were found to meet all eligibility criteria. Figure 1 describes a complete description of the search results and study selection process.

Characteristics of included studies

27 articles were not PubMed indexed and 2 of those were doctoral theses or masters dissertations. The oldest study was published in 1951 and the most recent in 2023. Out of the 52 articles, 31 studies were conducted in the Southeastern region of Brazil, 13 in the Southern region, 5 in the Midwest, 1 in the North and 1 in the Northwest. 22 (42%) studies were found to be indexed in PubMed. The majority of studies (54%) were published in the journal, Revista Brasileira Ortopedia. All studies were conducted within the public healthcare system. Figure 2 illustrates the evolving focus of studies included in this review, highlighting their areas of emphasis over time. See online supplemental Appendix IV for a full list of included studies.

Review findings

Epidemiology

Before the widespread availability and acceptance of ultrasound as a tool for diagnosis of DDH, the primary condition followed in the literature was hip instability as defined by a positive Ortolani sign. Arena (1973) studied a population of 2964 infants in their first 24 hours of life in Campinas, and found an incidence of hip instability, evidenced by this definition, in 7.42 of 1000 infants.[22] Over a 5-year period from 1978 to 1983, Volpon and Filho found an incidence of hip instability to be 2.31/1000 in a population of 16 429 infants in a single hospital in Ribeirão Preto.[23] Guarniero *et al*, analysing a population

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

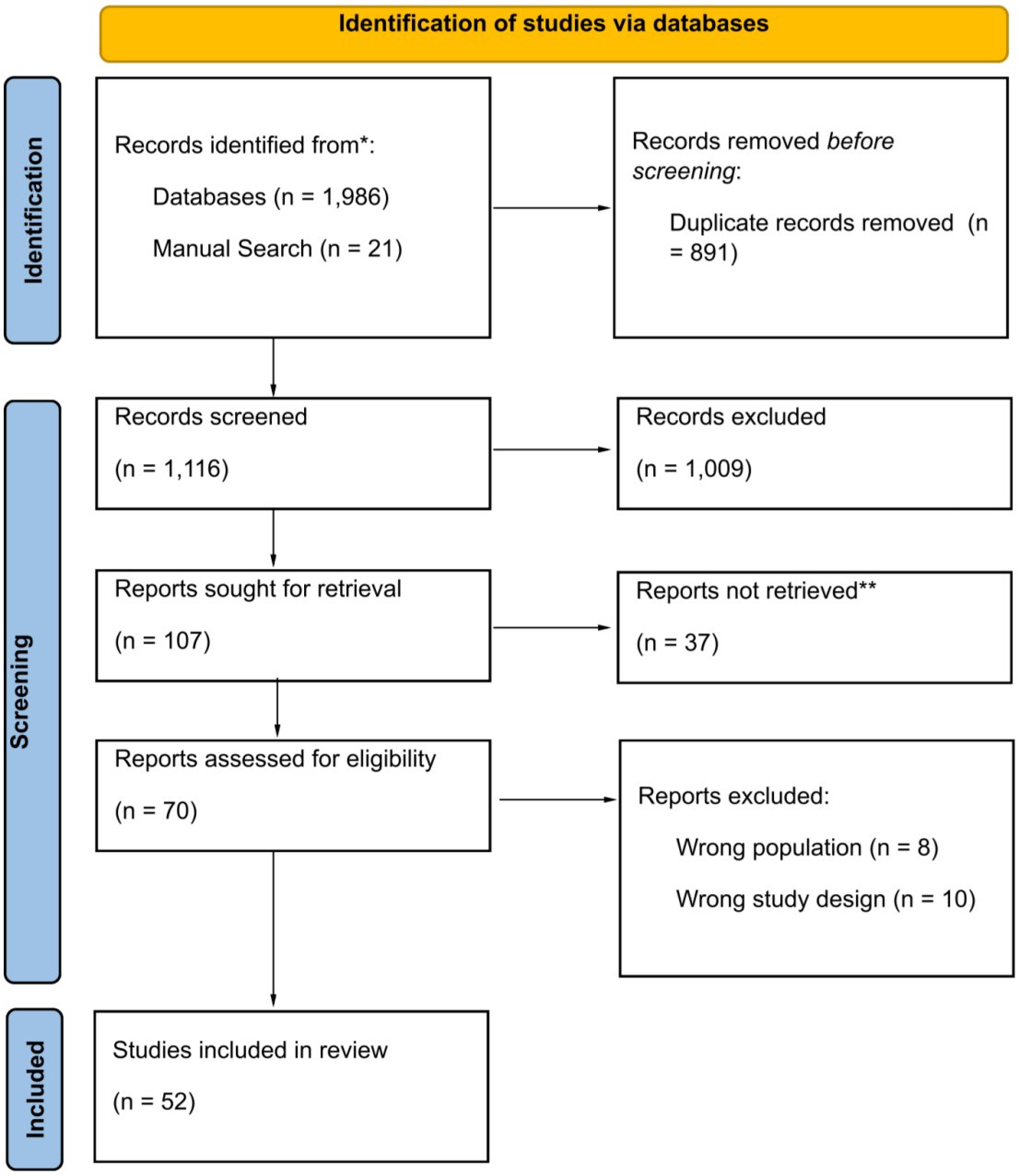

Figure 1 Search results and study selection and inclusion process. *The databases searched include Biblioteca virtual em saúde, Web of Science, Scopus and PubMed/MEDLINE, and Biblioteca Digital Brasileira de Teses e Dissertações. **Eight studies were not retrieved because the full text of the study was unable to be located. 29 studies were not retrieved because these studies were duplicates which were not detected earlier due to the study titles being presented in both Portuguese and English in different entries. From: Page MJ, *et al*.[59] PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

of 9171 infants in one maternity hospital in São Paulo in 1988, found an incidence of 5.01/1000.[24]

In more recent studies, ultrasound is used, either alone or in addition to physical exam manoeuvres, in the diagnosis of DDH. Ferreira used an approach in which infants were first screened by physical exam for a positive Ortolani sign, and those in which the signal was positive received further diagnostic investigation using ultrasound by the Graf method and radiographic evaluation. This study found a prevalence of congenital hip dislocation in 0.75/1000 recently born infants in a group of maternity hospitals in Campo Grande over a 6-month period.[25] Motta *et al*, who performed ultrasound exams on a cross-sectional sample of 678 infants in one maternity hospital in São Paulo in 2018, found a prevalence of 54.6/1000 of DDH as defined by Graf classification IIc or greater.[26] Demographic data for these epidemiological studies including incidence/prevalence, reported sex and race of diagnosed patients can be found in table 1.

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

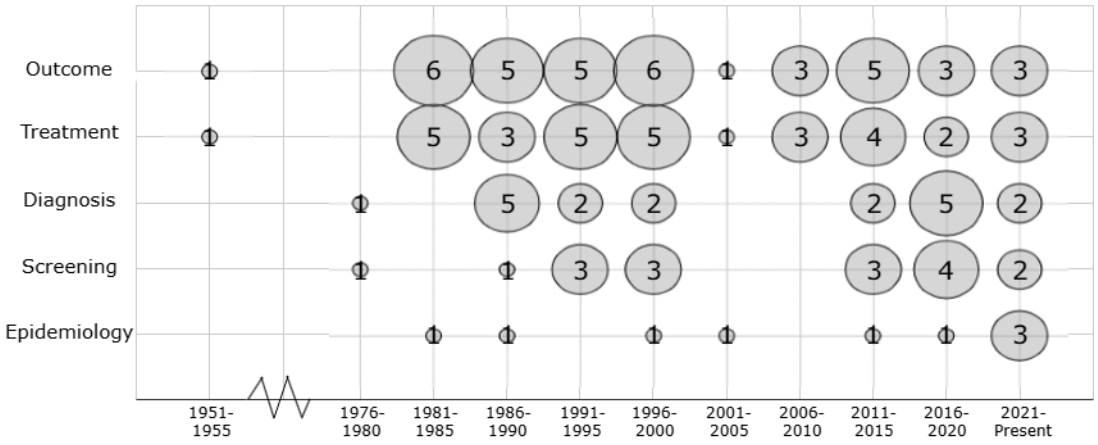

Figure 2 Focus of study of articles included in this review over time. If an article focused on more than one area of the study, it was counted more than once. Larger bubbles correspond to a greater number of articles, with the number in the bubble representing the count of articles which included that focus.

Screening

The published literature about screening for DDH in Brazil is limited. The above epidemiological studies take different approaches to making a diagnosis of DDH but do not provide any data concerning a comparison of screening approaches or long-term outcomes past diagnosis.

Diagnosis

Diagnosis was the subject of 14 studies and was achieved in all studies through physical examination, ultrasound or radiographs, or some combination of those three tools. All studies which used physical exam manoeuvres alone as a diagnostic standard considered a positive Ortolani sign to mean that the child had hip dysplasia. Radiographs were often mentioned in conjunction with physical exam manoeuvres to confirm the location of the femoral head in or out of the acetabulum along with the acetabular index, with Palhas describing radiographs as the 'gold standard' for diagnosis as late as 1991.[27]

The Graf method was the most common method of ultrasound examination, being used in some capacity in 11/15 (73%) of studies which mentioned the use of ultrasonography. The Harcke method of ultrasound diagnosis was the other common diagnostic standard described, used in two studies,[28 29] whereas the pubofemoral distance was studied in three separate articles against the Graf method as a possible alternative to the Graf method for diagnosis.[30–32] Studies in which the method of diagnosis of DDH was specified are listed in table 2.

Treatment and outcomes

Of the 27 studies which considered the treatment of DDH and its sequelae, 7 studied conservative treatments only, 17 studied surgical treatments only and 3 studied both.

Table 1 Incidence and prevalence rates of DDH found in all studies which published this information along with selected demographic data

Study	Motta *et al*[14]	Ferreira	Guarniero *et al*[24]	Volpon and Filho	Arena
Incidence/prevalence					
Rate per 1000	54.6	0.75	5.01	2.31	7.42
Sex					
Female	32 (86.5%)	29 (85.3%)	37 (80.4%)	29 (76.4%)	17 (77.3%)
Male	5 (13.5%)	5 (14.7%)	9 (19.6%)	9 (76.4%)	5 (22.7%)
Race					
White	30 (81%)	13 (38.2%)	35 (76.1%)	35 (92.2%)	--
Mixed-race	7 (19%)	18 (52.9%)	6 (13%)	0 (0%)	--
Black	0 (0%)	1 (2.9%)	4 (8.7%)	3 (7.8%)	--
Asian	0 (0%)	0 (0%)	1 (2.2%)	0 (0%)	--
No information		2 (5.9%)			22 (100%)

DDH, developmental dysplasia of the hip.

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

Table 2 Studies in which the method of diagnosis of DDH was specified

References	Reported age at examination	Method of diagnosis
Guarniero *et al*[49]	--	Ultrasound (observe for obvious luxation) against clinical exam+radiographs
Palhas and Pires[27]	Up to 6 months	US by Graf method+radiographs
Milani *et al*[50]	32 days (one child diagnosed)	US by Graf method
Meyer *et al*[29]	--	US by Harcke method+radiographs
Pacheco[28]	Mean: 7.79 weeks±6.44	Clinical exam+radiographs vs US by Graf method, Harcke method, Morin method
Jacobino *et al*[60]	Mean: 5 days	US by Graf method
Teixeira *et al*[31]	--	US by Graf method vs pubofemoral distance by US
Barbosa and Albernaz[43]	--	Clinical exam+US by Graf method
Cruz and Volpon[61]	Mean: 33 days±22.1	US by Graf method
Gonzalez *et al*[62]	--	Clinical exam+US by Graf method
Motta *et al*[32]	Mean: 40 days Range: 3 days - 4 months	US by Graf method vs pubofemoral distance by US

DDH, developmental dysplasia of the hip.

The two papers which provided information on the age of the patients at the initiation of treatment with a Pavlik harness reported average ages of 16.7 days and 31.5 days;[30 33] no study we identified recorded treating any child over 6 months of age with a Pavlik harness. Success rates in the studies which only considered conservative treatments ranged from 89% to 97%.

Regarding closed reduction, an older study by Volpon, examining patients from 1978 to 1983, used casting in flexion, abduction and external rotation to treat infants shortly after birth rather than a Pavlik harness.[23] Good results were achieved in 25/27 patients. Queiroz and Nomura analysed patients treated with both closed and open reduction and noted a negative relationship between age at initiation of treatment and magnitude of decrease in acetabular index at the end of treatment.[34]

Of the 21 studies which studied surgical treatments, 15 of them included pelvic osteotomies. All patients treated with pelvic osteotomies were older than 1 year and the great majority were younger than 10 years. Other surgical treatments mentioned were adductor tenotomies and femoral osteotomies. Among the pelvic osteotomies, 11/15 studies included treatment with a Salter or modified Salter osteotomy, 3/15 included cases with a Chiari osteotomy[35–37] and 1 examined outcomes of a Dega osteotomy.[38] One study from 1985 mentioned a technique, which was novel at the time, in which the acetabulum was extended superiorly with an autologous bone graft from the iliac crest.[39] This technique was not replicated in any other identified studies.

DISCUSSION

Wide variation among incidence and prevalence of DDH in Brazil was found among reported data, with numbers as low as 0.75/1000 in a study by Ferreira to 56.4/1000 in Motta *et al*'s study.[25 26] This range of values and the lack of data on incidence or prevalence in vast swaths of Brazil, such as the Northeast, North and South, suggests a need to continue efforts towards understanding the true burden of this disease in the country.

Although SUS is the largest public healthcare system in the world, there are limited data available for patients treated within SUS. In this review, all epidemiological studies on DDH using SUS data only examined diagnoses of hospitalised patients. There is currently no method of searching for patients with a specific diagnosis treated in an outpatient setting through SUS.[40]

A 2013 Cochrane review on screening programmes for DDH reported incidence rates of 34.0 and 60.3 per 1000 through diagnosis by ultrasonography and lower rates of 1.6–28.5 per 1000 through diagnosis by physical exam manoeuvres in the literature globally.[41] This information suggests that performing ultrasonography on more hips will lead to more diagnoses, which correlates with the limited data available regarding Brazilian populations collected in Motta's 2021 study on the prevalence of DDH.[26]

The literature highlights several key risk factors for DDH, such as birth order, female sex, a family history of DDH, hip clicking, breech presentation and associated congenital malformations.[2 42] Since these risk factors cannot be modified, primary prevention of DDH is not feasible. Therefore, secondary prevention, which involves thorough screening and early diagnosis, is essential for managing this condition effectively. The screening process in DDH mostly relies on established risk factors and clinical examinations. Consistent with existing literature, our findings showed a higher incidence among females across all studies, despite the absence of gender-specific restrictions.[2 42] Moreover, breech presentation, family history and other orthopaedic conditions are often observed as significant risk factors. Barbosa and Albernaz

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

conducted a cross-sectional study in 2019 with a sample of 33 DDH patients that showed a four times higher probability of DDH in female children and 15 times higher probability in breech presentation newborns.[43] Additionally, no statistically significant association was found regarding birth weight, gestational age, ethnicity and maternal age. Evaluating race as a risk factor was imprecise due to the heterogeneous nature of the Brazilian population, where racial identity is self-reported and often omitted in studies. Although the combination of these risk factors indicates a higher likelihood of DDH, their individual predictive accuracy remains limited.[8]

Clinical examinations are frequently cited in the literature, yet few studies in this review detail the specific procedures and the health professionals involved. Among the 15 studies that reported clinical examinations for screening and diagnostic purposes, 7 were conducted by paediatricians and 1 by a nursery specialist. Only nine of these studies described evaluations performed by orthopaedic specialists. The Ortolani and Barlow tests were the most commonly used assessments. Although these tests exhibit high specificity for detecting hip abnormalities, their sensitivity is limited.[44 45] These examinations are vital for secondary prevention.

Ultrasound has been considered the imaging modality of choice for the diagnosis of DDH for babies up to 6 months of age due to a cartilaginous femoral head. Most techniques still used currently were first described in the 1980s.[46–48] Guarniero was the first to describe ultrasound in the diagnosis of DDH in a Brazilian population subset in 1986.[49] This study considered a hip abnormal if the anatomical relationship of the components of the joint appeared at all unusual to the observer. Palhas was the first to report the Graf method of ultrasound in Brazilian patients.[27] Milani *et al* further established the Graf method as a standard of diagnosis in Brazil with a comparative study between Brazilian and Italian infants.[50]

Treatment for DDH follows a predictable escalation, with younger patients receiving conservative treatment and older patients needing progressively more invasive and complex forms of treatment.[51] Infants diagnosed with DDH are almost always treated first with abduction splinting, most commonly with a Pavlik harness, which maintains the hips in flexion and abduction to facilitate the development of the acetabulum.[51] In this review, no study recorded treating any child over 6 months of age with a Pavlik harness and no information was available regarding the average time between diagnosis and initiation of treatment or the effect of that time on treatment outcomes.

The reported success rates of treatment were high, but no study was conducted with a rigorous methodological framework, such as a randomised controlled trial. Given that there continues to exist uncertainty in the exact efficacy of abduction splinting for treatment of DDH, the amount and quality of information on early and conservative treatment of DDH in Brazilian children is inadequate to further inform treatment in the country.[11 52] Because early treatment for DDH requires that all children with the disease are diagnosed, the lack of information on the epidemiology of and screening for DDH makes early treatment more difficult to achieve and study. As a result, much of the interest found in the literature is focused on late-presenting disease which necessitates complex surgical management.

Out of the 52 studies included in this review, 33 address treatment aspects and among those 24 (72%) focused on surgical interventions. The gap between diagnosis and treatment is not mentioned in any study. That is crucial information, which made it impossible to estimate the number of late-diagnosed DDH cases in Brazil.

There are several types of surgical treatment for DDH and current literature available does not clearly establish the superiority of any single technique.[53] Except for rare cases where one technique is more appropriate than another, the choice of surgical procedure typically depends on the surgeon's preference and experience. The surgical techniques reported in the studies include: hip adductor tenotomy, Salter osteotomy (with or without Ombrédanne's modification), modified Salter osteotomy (with or without femoral shortening), Chiari osteotomy (with or without femoral shortening), Dega osteotomy, Pemberton osteotomy, Steel osteotomy, Kalamchi osteotomy, shelf osteotomy, Mubarak modification, supracondylar derotational femoral osteotomy, subtrochanteric varus osteotomy and a novel technique involving acetabular extension with autologous bone grafts from the iliac crest. We found four studies comparing different surgical treatments techniques performed in the Brazilian population.[37 53–55]

Outcomes related to surgical treatments frequently highlight AVN of the hip as the most serious complication post-DDH treatment. It is widely accepted that alterations in blood supply to the femoral head cause this complication, but uncertainty remains about its incidence and predisposing factors. Early studies reported AVN incidences ranging from 0% to 67%.[56] In our review studies, reported incidence of AVN varied from 0% to 40%. It is difficult to point out reasons for this wide variation, but it might be related to the limited number of patients in many studies, as the surgical study with the highest number of patients reported no cases of AVN examined 22 hips treated.[57]

13 studies informed the necessity of secondary procedures due to residual subluxation, redislocation or persistent valgus deformities. Regardless of follow-up duration, studies frequently lack information on the long-term quality of life and functional capacity of the children operated. Much work remains to be done to better understand patient-important outcomes of surgical management.

Souza *et al* discussed the incidence and costs of surgical treatment of DDH in the Brazilian Public Health System over a decade, using public data based on Hospital Admission Authorizations.[58] Their study revealed that southern states had higher treatment rates (0.73/1000),

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

followed by southeast states, which had the highest absolute frequency of cases (46.7%) and patient flow. From January 2008 to December 2017, there were 14 584 hospitalisations for primary hip dysplasia (International Classification of Disease, tenth revision code - Q65) in Brazil's SUS, with 8592 cases undergoing specific hospital treatment for dysplasia, costing an average of R$2225.50 per case and a total of R$19 124 086.25.

This represents a substantial financial burden for the Public Health System. Thus, considering the costs, resolution rates of conservative treatment and associated complications rates of surgical treatment, the early diagnosis associated with an appropriately conservative treatment might be the most cost-effective approach for managing DDH in national proportions.

There are currently no national guidelines for DDH screening in Brazil. Without understanding the burden of the disease, it is difficult to make informed decisions about the most appropriate screening protocol. More work should be done to understand the prevalence of DDH in all of Brazil.

To our knowledge, this is the first scoping review to study DDH specifically in the Brazilian population. Its strengths include its rigorous search methodology including manual review of historical sources and review of articles in all languages found. Limitations of this scoping review included the difficulties of identifying all sources in grey literature and the lack of standardised reporting protocol in the literature leading to variability in the data available.

This review reported the historical overview of DDH in Brazil and provided valuable information identifying gaps that may help in designing policies which take in account variations throughout the country and challenges revealed by the studies. Future studies may assist in filling these gaps through focus on epidemiology of the disease, particularly in the less studied regions of the country outside of the Southeast. Additionally, research into the efficacy of screening programmes and conservative treatment would assist in avoiding preventable sequelae of DDH.

CONCLUSION

This scoping review explored the available literature on DDH in the Brazilian population to investigate variations in epidemiology, screening, diagnosis, treatment and outcomes across the country. The majority of epidemiological studies found were conducted in isolated populations, mostly in the Southeast of Brazil—there is no general estimation of prevalence in Brazil. There is a need for comprehensive studies to understand the prevalence and incidence of DDH in the country. Additionally, there is a need for a longitudinal prospective study of screening programmes. It was found that the Graf method of ultrasonography is the method of choice for diagnosis, but the availability of ultrasound devices and trained operators is unknown throughout Brazil. Although the mainstay of treatment for DDH is conservative, the majority of studies performed investigated surgical treatments. There should be a greater focus in Brazil on progressing understanding of conservative treatments, including their challenges and limitations. More information on DDH in Brazil is necessary to properly design and implement effective screening and treatment programmes. Future research should be done to understand the prevalence of the disease, optimal forms of screening and early treatment.

Author affiliations
[1]Universidade de Sao Paulo Faculdade de Medicina, Sao Paulo, Brazil
[2]Rutgers New Jersey Medical School, Newark, New Jersey, USA
[3]Department of Orthopaedic Surgery, The University of British Columbia Faculty of Medicine, Vancouver, British Columbia, Canada
[4]Orthopaedics, The University of British Columbia Faculty of Medicine, Vancouver, British Columbia, Canada
[5]Instituto de Ortopedia e Traumatologia, Hospital das Clinicas HCFMUSP, Faculdade de Medicina, Universidade de Sao Paulo, Sao Paulo, Brazil

Contributors The authors confirm their contribution to the paper as follows: study conception and design: PMG and ES; search strategy development: PECMRJ, SL and SA; data collection: DFL, PECMRJ and PMG: draft manuscript preparation: PECMRJ, PMG and DFL; review and comment on the manuscript: ES and DFL. All authors reviewed and approved the final version of the manuscript. PMG is the guarantor of the manuscript.

Funding PECMRJ received a scholarship from the National Council of Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico—CNPq, Process number: 163832/2023-4)

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Readers interested in using our database on DDH for purposes related to their research are invited to contact the corresponding author for further details.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID iDs
Daniel Frank Liggio http://orcid.org/0000-0002-3863-6093
Emily Schaeffer http://orcid.org/0000-0002-3263-6586
Patricia Moreno Grangeiro http://orcid.org/0000-0002-1533-659X

REFERENCES

1 What is hip dysplasia. International hip dysplasia institute. 2024. Available: https://hipdysplasia.org/developmental-dysplasia-of-the-hip
2 Loder RT, Skopelja EN. The epidemiology and demographics of hip dysplasia. *ISRN Orthop* 2011;2011:238607.
3 Sioutis S, Kolovos S, Papakonstantinou M-E, *et al*. Developmental dysplasia of the hip: a review. *J Long Term Eff Med Implants* 2022;32:39–56.

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

4 Kuitunen I, Uimonen MM, Haapanen M, *et al*. Incidence of neonatal developmental dysplasia of the hip and late detection rates based on screening strategy: a systematic review and meta-analysis. *JAMA Netw Open* 2022;5:e2227638.
5 Duarte ML, Motta GGB, Rodrigues NVM, *et al*. Ultrasound techniques for the detection of developmental dysplasia of the hip: a systematic review and meta-analysis. *Sao Paulo Med J* 2022;141:154–67.
6 Koşar P, Ergun E, Unlübay D, *et al*. Comparison of morphologic and dynamic US methods in examination of the newborn hip. *Diagn Interv Radiol* 2009;15:284–9.
7 Omeroğlu H. Use of ultrasonography in developmental dysplasia of the hip. *J Child Orthop* 2014;8:105–13.
8 Shaw BA, Segal LS, SECTION ON ORTHOPAEDICS. Evaluation and referral for developmental dysplasia of the hip in infants. *Pediatrics* 2016;138:e20163107.
9 Mulpuri K, Song KM. AAOS clinical practice guideline: detection and nonoperative management of pediatric developmental dysplasia of the hip in infants up to six months of age. *J Am Acad Orthop Surg* 2015;23:206–7.
10 Developmental dysplasia of the hip. NHS. 2022 Available: https://www.nhs.uk/conditions/developmental-dysplasia-of-the-hip
11 O'Beirne JG, Chlapoutakis K, Alshryda S, *et al*. International interdisciplinary consensus meeting on the evaluation of developmental dysplasia of the hip. *Ultraschall Med* 2019;40:454–64.
12 Schaeffer EK, Study Group I, Mulpuri K. Developmental dysplasia of the hip: addressing evidence gaps with a multicentre prospective international study. *Med J Aust* 2018;208:359–64.
13 Chand S, Aroojis A, Pandey RA, *et al*. The incidence, diagnosis, and treatment practices of developmental dysplasia of hip (DDH) in India: a scoping systematic review. *Indian J Orthop* 2021;55:1428–39.
14 Motta GGB, Rodrigues NVM, Braga SR, *et al*. The reality of sonography of the infant hip in Brazil: results and recommendations. *Explor Musculoskeletal Dis* 2024;2:156–63.
15 Poacher AT, Hathaway I, Crook DL, *et al*. The impact of the introduction of selective screening in the UK on the epidemiology, presentation, and treatment outcomes of developmental dysplasia of the hip. *Bone Jt Open* 2023;4:635–42.
16 Ömeroğlu H, Köse N, Akceylan A. Success of pavlik harness treatment decreases in patients ≥ 4 months and in ultrasonographically dislocated hips in developmental dysplasia of the hip. *Clin Orthop Relat Res* 2016;474:1146–52.
17 Dezateux C, Rosendahl K. Developmental dysplasia of the hip. *Lancet* 2007;369:1541–52.
18 Woodacre T, Dhadwal A, Ball T, *et al*. The costs of late detection of developmental dysplasia of the hip. *J Child Orthop* 2014;8:325–32.
19 Castro MC, Massuda A, Almeida G, *et al*. Brazil's unified health system: the first 30 years and prospects for the future. *Lancet* 2019;394:345–56.
20 Peters MDJ, Godfrey C, McInerney P, *et al*. Scoping reviews. In: AromatarisE, Lockwood C, Porritt K, et al, eds. *JBI manual for evidence synthesis*. JBI, 2020. Available: https://synthesismanual.jbi.global
21 Tricco AC, Lillie E, Zarin W, *et al*. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169:467–73.
22 Arena JFP. Instabilidade congênita do quadril sinal de estalido na articulação coxofemoral em recém-nascidos de uma população brasileira. *Rev Ass Med Brasil* 1976;22:276–80.
23 Volpon JB, Filho GC. Luxação congênita do quadril no recém-nascido. *Rev Bras Ortop* 1985;20:317–20.
24 Guarniero R, Montenegro NB, Vieira PB, *et al*. Sinal de Ortolani: resultado do exame ortopédico em 9.171 recém-nascidos na Associação Maternidade de São Paulo. 1988;23:125–8.
25 Ferreira AP. *Prevalência de luxação congênita do quadril em recém natos de julho a dezembro/2009 em campo grande - ms* [Unpublished doctoral dissertation/master 's thesis]. Universidade Federal do Mato Grosso do Sul, 2011
26 Motta GGB, Chiovatto ARS, Chiovatto ED, *et al*. Prevalência de displasia do desenvolvimento do quadril em uma maternidade de São Paulo, Brasil. *Rev Bras Ortop (Sao Paulo)* 2021;56:664–70.
27 Palhas TAG, Pires MEE. Luxação congênita do quadril: ultra-sonografia e radiologia. *Rev Bras Ortop* 1991;26:313–6.
28 Pacheco EMB. *Avaliação ultra-sonográfica do diagnostico e tratamento da displasia do desenvolvimento do quadril* [Unpublished doctoral dissertation/master 's thesis]. Faculdade de Ciências Médicas da Universidade Estadual de Campinas, 1997
29 Meyer AT, Forlin E, Pauleto AC, *et al*. Avaliação de crianças com suspeita de displasia congênita do quadril com idade entre zero e seis meses. *Acta Ortop Bras* 1997;5:59–64.
30 Maranho DA, Donati FN, Dalto VF, *et al*. The pubo-femoral distance decreases with Pavlik harness treatment for developmental dysplasia of the hip in newborns. *Skeletal Radiol* 2017;46:1201–7.
31 Teixeira SR, Dalto VF, Maranho DA, *et al*. Comparison between Graf method and pubo-femoral distance in neutral and flexion positions to diagnose developmental dysplasia of the hip. *Eur J Radiol* 2015;84:301–6.
32 Motta GGB, Chiovatto ARS, Chiovatto ED, *et al*. Measurement of pubofemoral distance in the diagnosis of developmental dysplasia of the hip: sensitivity and specificity. *J Ultrasound Med* 2022;41:1205–12.
33 Angelini JA, Ventosa MF, Davitt M, *et al*. Uso do suspensório de Pavlik no tratamento da displasia congênita de quadril no pacientes de instituição pública de saúde. *Rev Bras Ortop* 1997;32:305–9.
34 Queiroz CE, Nomura AM. O desenvolvimento acetabular na luxação congênita do quadril. *Rev Bras Ortop* 1993;28:583–8.
35 Moura J, Radaeli RF, Carrazone OL, *et al*. Femoral overgrowth following surgical treatment of long-established dysplasia of the hip. *Acta Ortop Bras* 2009;17:139–43.
36 Cordeiro EF, Matsunaga FT, Costa MP, *et al*. Análise radiográfica dos fatores prognósticos no tratamento do quadril displásico inveterado. *Acta ortop bras* 2010;18:218–23.
37 Dobashi ET, Kiyohara RT, Matsuda MM, *et al*. Inveterate dysplasic hip - a surgical treatment. *Acta Ortop Bras* 2006;14:183–9.
38 Guarnieiro R, Sanchez FB, Massa BSF, *et al*. Modified dega osteotomy in treating developmental dysplasia of the hip. *Acta Ortop Bras* 2018;26:30–2.
39 Napoli MM, Lage Jde A, Basile Júnior R. Neoteto pediculado no tratamento cirúrgico das luxações patológicas e displasias do quadril. Resultados preliminares [New ceiling pedicle in the surgical treatment of pathological dislocations and hip dysplasias. Preliminary results]. *Rev Hosp Clin Fac Med Sao Paulo* 1985;40:254–7.
40 DATASUS Tecnologia da Informação a Serviço do SUS [internet]. Ministério da saude. 2020. Available: http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sih/cnv/niuf.def
41 Shorter D, Hong T, Osborn DA. Cochrane review: screening programmes for developmental dysplasia of the hip in newborn infants. *Evid Based Child Health* 2013;8:11–54.
42 Gulati V, Eseonu K, Sayani J, *et al*. Developmental dysplasia of the hip in the newborn: a systematic review. *World J Orthop* 2013;4:32–41.
43 Barbosa R de O, Albernaz EP. Profile of patients diagnosed with developmental dysplasia of the hip. *Rev Bras Ortop (Sao Paulo)* 2019;54:497–502.
44 Burger BJ, Burger JD, Bos CF, *et al*. Neonatal screening and staggered early treatment for congenital dislocation or dysplasia of the hip. *Lancet* 1990;336:1549–53.
45 Poul J, Bajerova J, Sommernitz M, *et al*. Early diagnosis of congenital dislocation of the hip. *J Bone Joint Surg Br* 1992;74:695–700.
46 Graf R. The diagnosis of congenital hip-joint dislocation by the ultrasonic combound treatment. *Arch Orth Traum Surg* 1980;97:117–33.
47 Harcke HT, Clarke NM, Lee MS, *et al*. Examination of the infant hip with real-time ultrasonography. *J Ultrasound Med* 1984;3:131–7.
48 Terjesen T, Bredland T, Berg V. Ultrasound for hip assessment in the newborn. *J Bone Joint Surg Br* 1989;71:767–73.
49 Guarniero R, Grigoletto Júnior W, Barros JC, *et al*. Ultra-sonografia no diagnóstico precoce da luxação congênita do quadril [Ultrasound in the early diagnosis of congenital hip dislocation]. *Rev Hosp Clin Fac Med São Paulo* 1986;41:194–7.
50 Milani C, Napoli MMM, Filho JL, *et al*. Estudo ultra-sonográfico de 400 quadris em crianças com até nove meses de idade pelo método de Graf. *Rev Bras Ortop* 1993;28:20–4.
51 Weinstein SL. Chapter 22: developmental hip dysplasia and dislocation. In: Weinstein SL, Flynn JM, Crawford HA, eds. *Lovell and Winter's Pediatric Orthopaedics*. 8th edn. 2021: 963–1089.
52 Dwan K, Kirkham J, Paton RW, *et al*. Splinting for the non-operative management of developmental dysplasia of the hip (DDH) in children under six months of age. *Cochrane Database Syst Rev* 2022;10:CD012717.
53 Feeley IH, Green CJ, Rowan FE, *et al*. International variance in the treatment of developmental dysplasia of the hip. *J Child Orthop* 2014;8:381–6.
54 da Rocha VL, Marques GL, da Silva LJ, *et al*. Clinical and radiographic medium-term evaluation on patients with developmental dysplasia of the hip, who were submitted to open reduction, capsuloplasty and Salter osteotomy. *Rev Bras Ortop* 2014;49:51–5.
55 Kotzias Neto A, Ferraz A, Bayer Foresti F, *et al*. Bilateral developmental dysplasia of the hip treated with open reduction and

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

Salter osteotomy: analysis on the radiographic results. *Rev Bras Ortop* 2014;49:350–8.
56 Domzalski M, Synder M. Avascular necrosis after surgical treatment for development dysplasia of the hip. *Int Orthop* 2004;28:65–8.
57 Milani C, Ishida A, Filho JL, *et al*. Tratamento cirúrgico da luxação congênita do quadril inveterada pelo encurtamento femoral e acetabuloplastia de Salter modificada. *Rev Bras Ortop* 1996;31:1–10.
58 Souza BGSE, Vasconcelos BMC, Pujoni HP, *et al*. Epidemiology and costs of surgical treatment of developmental dysplasia of hip in the Brazilian Public Health System in a decade. *Einstein (Sao Paulo)* 2021;19:eGS5625.
59 Page MJ, McKenzie JE, Bossuyt PM, *et al*. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:71.
60 Jacobino B de CP, Galvão MD, da Silva AF, *et al*. Using the Graf method of ultrasound examination to classify hip dysplasia in neonates. *Autops Case Rep* 2012;2:5–10.
61 Cruz MAF, Volpon JB. Orthopedic and ultrasound assessment of hip stability of newborns referred by pediatricians with suspected Developmental Dysplasia. *Rev Col Bras Cir* 2020;46.
62 Gonzalez FC, Fontes F, Maia G de AS, *et al*. Orthopedic assessment of the hips in newborns after initial pediatric survey. *Acta Ortop Bras* 2019;27:304–7.

BMJ Open: first published as 10.1136/bmjopen-2024-094660 on 7 February 2025. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.