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# Global clubfoot treatment in 2023: an overview of advances and outcomes

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## ABSTRACT

**Introduction** Approximately 200 000 children are born each year with clubfoot, the majority of whom live in low-income and middle-income countries (LMICs). If untreated, clubfoot causes pain and reduced mobility, leading to activity limitations and disability. The Ponseti method is a highly effective and minimally invasive treatment. This observational study aims to quantify the countries providing clubfoot services and the children receiving treatment in 2023 and compares progress since data were first collected in 2005.

**Methods** In January and February 2024, data on clubfoot treatment in 2023 were collected from 70 countries. Informants completed a survey about new cases enrolled, treatment outcomes and health system integration. Data were analysed using descriptive statistics, with adjustments made for duplicates, and included clinic locations, the number and ages of children starting treatment, types of support available and Ministry of Health involvement. We compared coverage trends over time and used a cartogram to visualise the extent of clubfoot programme coverage across countries.

**Results** Responding countries accounted for 83% of all expected cases in LMICs. There was an increase in enrolment numbers, to 40 382, in 2023. Despite this progress, treatment coverage remained low at approximately 22% across respondent countries. While integration of clubfoot services into national healthcare systems varied widely, strong public–private partnerships in many countries suggest a foundation for sustainable, long-term treatment programmes. However, quality care remained a challenge, with only 67% of children receiving their first foot abduction brace, indicating gaps in ensuring comprehensive treatment necessary for successful clubfoot management. Lingering effects of COVID-19 restrictions include a higher percentage of cases enrolled after 1 year of age.

**Conclusions** A larger proportion of children in LMICs received Ponseti treatment in 2023 compared with 2005. However, more work is needed to expand national programmes, build sustainable, high-quality treatment capacity and ensure all children get the care they need to avoid lifelong disability.

### WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The Ponseti method, now the gold standard for clubfoot treatment, has been increasingly adopted worldwide over the past 2–3 decades.

⇒ Despite this, in 2015, only 15% of children with clubfoot in low-income and middle-income countries accessed treatment, leaving approximately 144 000 untreated.

### WHAT THIS STUDY ADDS

⇒ This study demonstrates that scaling of Ponseti treatment in low-income and middle-income countries (LMICs) is feasible using a comprehensive clubfoot programme based on public health principles. In several LMICs, over 50% of babies born with clubfoot now receive treatment. Progress has been made through a coordinated approach to achieve maximum global coverage by Global Clubfoot Initiative members. However, there remains an urgent need to address the 80% of cases in LMICs still without access to treatment.

### HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Clubfoot care should be included in global and national health guidelines for maternal and child health. A focus on early diagnosis, timely referrals and treatment, including surgery and assistive products, can strengthen health systems through improving coordination and how resources and services are managed. Including these services in national health plans is necessary to ensure that all children receive complete care from birth. This approach may contribute to ensuring that rehabilitation is available and effective for every child with congenital conditions.

## INTRODUCTION

Clubfoot, or congenital talipes equinovarus, is a congenital deformity where a baby's foot is fixed in a downward and inward position.[1] It affects approximately 1.2 in 1000 live births globally,[2] and prevalence rates vary by region. Clubfoot is more common in low-income and middle-income countries (LMICs),[2] and access to treatment is often limited due to scarce resources, a shortage of trained providers, weak healthcare systems and socioeconomic challenges.[3 4] Untreated clubfoot can lead to physical limitations, including pain, difficulty walking and reduced mobility.[4] These limitations affect quality of life and make it harder to engage in everyday activities, which may lead to social exclusion and disability.

Improving treatment access for children with clubfoot is therefore crucial for achieving health targets and development goals. It will be difficult to achieve the Sustainable Development Goals, including Goal 3 (Good Health and Well-being), SDG 4 (Quality Education) and Goal 10 (Reduced Inequality), without disability-inclusive solutions.[5] Exclusion from healthcare violates the rights of children with clubfoot as outlined in the United Nations Convention on the Rights of the Child (UNCRC) and national laws. It also matters to children with clubfoot and their families whether they have a good quality of life.[6–10]

Globally, the Ponseti treatment is considered the gold standard for treatment of clubfoot.[11] This minimally invasive approach includes serial manipulation and application of plaster casts over several weeks and a minor, outpatient surgical procedure to correct the equinus deformity. This process is followed by wearing a brace full-time for the first 3 months and then only at night until 4–5 years of age. The method is widely recognised as effective, with a 95% success rate in the initial correction of the deformity when it is started in infancy.[12 13] The Ponseti treatment is also cost-effective and simple to implement when the standardised treatment protocol is followed diligently.[14 15] However, epidemiological data on clubfoot is incomplete in many parts of the world, particularly in LMICs where health systems are under-resourced.[2 16] This data gap hinders effective resource allocation and the planning of services. The lack of a specific WHO programme for clubfoot may also contribute to this congenital condition receiving limited attention within global health initiatives, potentially overlooking opportunities to improve care and outcomes.

To address these gaps, a comprehensive approach is required. For example, RunFree2030,[17] the strategy of the Global Clubfoot Initiative (GCI), seeks to expand treatment access worldwide. The initiative focuses on expanding geographical reach, raising awareness and improving service quality while integrating treatment into existing health systems. The strategy calls for governments and global leaders to provide evidence-based services, adopt standardised training and ensure clinics are well-staffed with necessary materials to maintain high-quality care. It recommends including the Ponseti method in preservice training for healthcare professionals to improve early diagnosis and referral. Success is measured by more trained clinicians, improved access to treatment and high-quality care meeting global standards.[17] RunFree2030 prioritises the needs of children and their families and offers a holistic, sustainable approach through global collaboration and equitable partnerships. Yet, a key challenge for many children with clubfoot is limited access to treatment, the full extent of which remains unclear due to the most recent published global data being from 2015.[3]

We, therefore, aimed to evaluate the current state of clubfoot management in LMICs, identify gaps in data and service provision, determine the level of treatment quality, and the extent of integration, and propose actionable solutions to improve outcomes for affected children and their families. Objectives included assessing the coverage of clubfoot services, exploring opportunities for integrating clubfoot care into broader health systems and recommending strategies for enhancing global health initiatives.

## METHODS

In January and February 2024, a global survey was conducted by the GCI on new clubfoot cases enrolled in treatment in 2023. GCI was launched in 2010 to unite the efforts of organisations involved with clubfoot, working towards a shared vision that all children born with clubfoot would receive the treatment that they need. The initiative is now a network of approximately 60 organisations in over 70 countries that treat clubfoot and has conducted biennial global surveys of clubfoot services since 2007. The questionnaire was distributed electronically, and respondents were reminded at least twice.

For the survey, LMIC countries were categorised based on their Ponseti service availability:

Category A: Countries with known Ponseti services and contacts.

Category B: Countries with some evidence of Ponseti services but no known contacts.

Category C: Countries with no evidence of Ponseti services or contacts.

Data sources were sought for all LMICs with more than 50 expected cases of clubfoot annually and were requested from 134 category A and category B countries. Category B countries were contacted after obtaining details through internet searches. Category C countries, lacking evidence of Ponseti services, were not contacted. We found no evidence of clubfoot services in these 37 countries despite reaching out to our network and conducting extensive internet and social media searches. Data collection covered treatment delivered between January and December 2023, using a standardised form (online supplemental appendix 1). Information requested included clinic locations, numbers and ages of children starting and completing treatment, treatment quality indicators, types of support available, health system integration and Ministry of Health involvement. Data were self-reported by national clubfoot programme coordinators and individual practitioners.

Data were analysed using descriptive statistics. Data from each country were adjusted for duplicates where multiple respondents were involved. Economic groupings were based on World Bank Income Group classifications.[18] Population data were extracted from population and demographic data from global and regional organisations, including the United Nations,[19] national statistical offices, Eurostat,[20] the US Census Bureau[21] and the Secretariat of the Pacific Community.[22]

‘Expected cases’ were calculated using the regional birth prevalence of clubfoot,[2] estimated country population and birth rate.[18–22] Coverage was defined as the proportion of children under 1 year of age who were enrolled in treatment during their birth year (2023) relative to the expected number of cases for that year. To calculate coverage, we first determined the expected number of cases from the population data sources.[18–22] We then calculated the actual number of children enrolled in treatment in 2023 and expressed this as a percentage of the expected cases. We compared coverage in 2023 to coverage rates from previous years to assess trends in enrolment over time. We used data from 14 countries as a reference to validate our calculations and account for variability in data.[3] Data from these 14 countries (DR Congo, Ethiopia, Ghana, Kenya, Malawi, Niger, Rwanda, Zambia, Afghanistan, Bangladesh, India, Dominican Republic, Haiti and Honduras) acted as a ‘sense check’ to verify if the reported increase in enrolment numbers is a genuine rise rather than just a result of more countries providing data. These countries were selected because GCI has consistent data from them over the entire period, often from a single reliable source.

We evaluated several key indicators for the analysis of treatment outcomes. We determined the number of children who completed the correction phase of clubfoot treatment within eight casts, which can show clinical competence.[23] We summarised the number of children who received a tenotomy, which is required in 90% of cases to obtain full dorsiflexion. We calculated the proportion of children who were fitted with a first foot abduction brace, which plays a critical role in maintaining the correction achieved through the casts and surgery. These metrics inform effectiveness and adherence to the treatment protocol. Additionally, the first foot abduction brace fitting indicates that: (1) the corrective phase of treatment was completed without dropout, (2) the foot was sufficiently corrected to fit into a foot abduction brace (requires 60° midfoot abduction and 10+ degrees dorsiflexion) and (3) a brace was available. We converted numerical data about being fitted for a foot abduction brace into proportions and stratified the data into four categories (0%–25%, 26%–50%, 51%–75% and 76%–100%) to identify and compare patterns.

A cartogram was developed to show the conventional view of world land masses for reference, and proportional land masses based on current births of children with clubfoot and clubfoot programme coverage.

Clubfoot service integration indicators were analysed using descriptive statistics for each country.

### Public and patient involvement

None.

## RESULTS

The expected number of babies born with clubfoot in 2023 in LMICs was 165 678, representing 93% of all global cases. Data were obtained from 70 countries (53% of all LMICs), accounting for 84% (n=138 684) of the expected cases in LMICs. The response rate was 52% (data were requested from 134 countries).

The total number of children enrolled in clubfoot treatment has increased since 2005 (figure 1), and this was also the case for the 14 reference countries

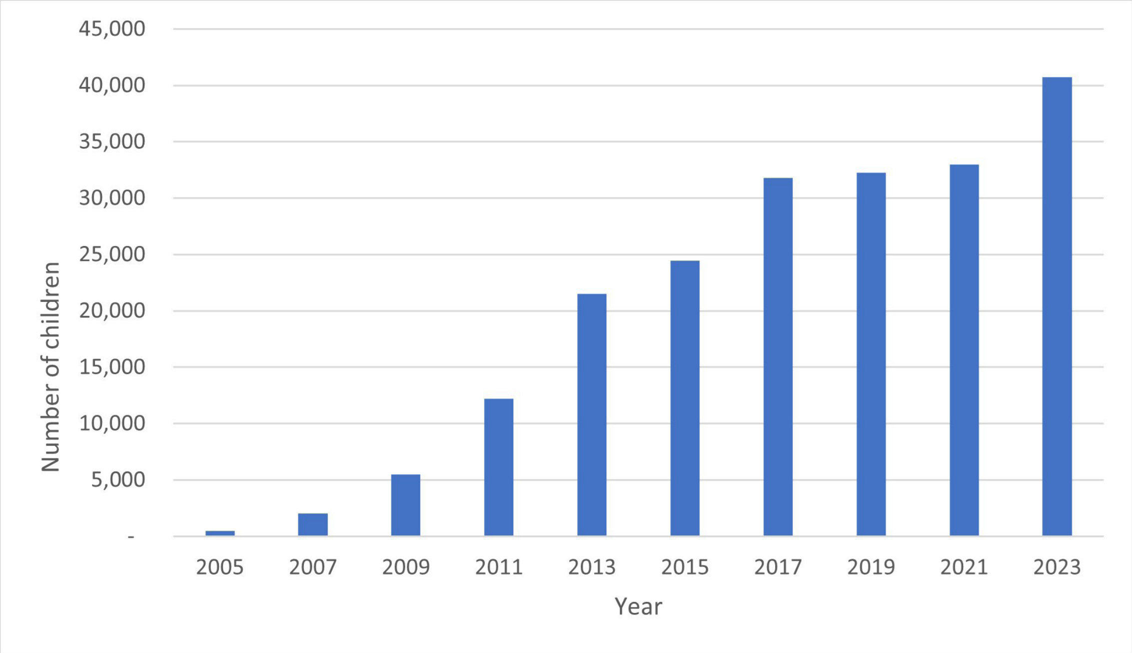


**Figure 1** Number of children enrolled in clubfoot treatment in LMIC 2005–2023. LMIC, low-income and middle-income countries.

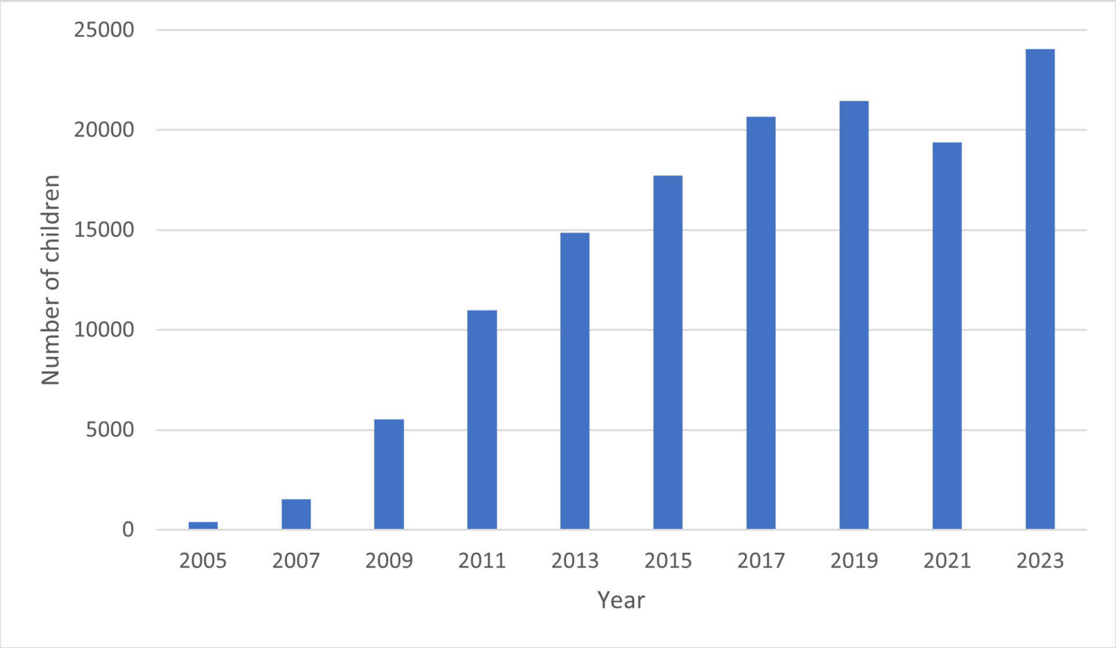


**Figure 2** Number of children enrolled in clubfoot treatment in 14 reference countries.

(figure 2). The data indicate a plateau in coverage rates between 2019 and 2021, likely attributable to the disruptions caused by the COVID-19 pandemic. From the two previous surveys (unpublished),[24] clubfoot services were disrupted by COVID-19 by 65% in 2020 and 33% in 2022. These disruptions impacted healthcare access, service delivery and the ability to enrol children in treatment programmes, resulting in lower or unchanged coverage levels compared with prepandemic trends.

In 2023, 40 382 children were enrolled for Ponseti treatment in LMICs, which corresponds to a coverage of 22% of expected cases in respondent countries (figure 3).

Among the treated children, 73% were under the age of 1 year, and 86% were under the age of 2 years (figure 4). The total number of children enrolled under 1 year was 29 618, which accounts for 22% of the total expected 137 432 cases in respondent countries.

In the correction phase, the proportion of children who received fewer than eight casts varied widely. Three countries fall into the 0%–10% range, and two are in the 20%–30% and 30%–40% ranges. Conversely, 54% of countries reported greater than 80% of children receiving fewer than 8 casts, with 12 countries reporting 80%–90% of children treated, and 21 countries indicated this in 90%–100% of the children treated (online supplemental table 1).

The data on Achilles' tendon tenotomy also shows variation in the proportion of children receiving this procedure. Nine countries reported that 50%–60% of children received this procedure, while four countries fell into the 60%–70% range. 11 countries reported 70%–80% and another 11 countries

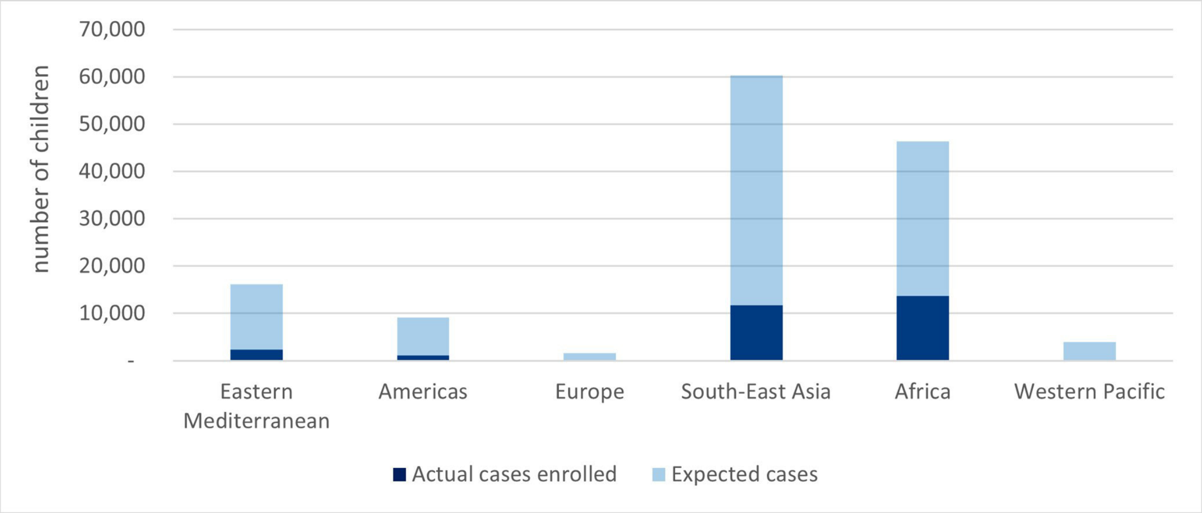


**Figure 3** Expected cases versus actual cases enrolled by region.

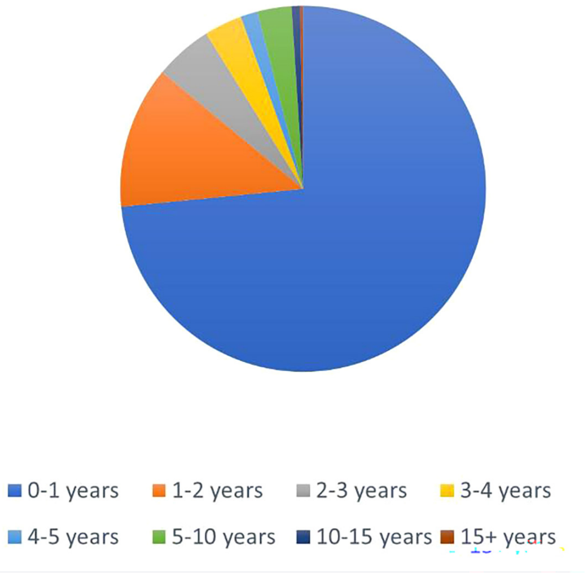
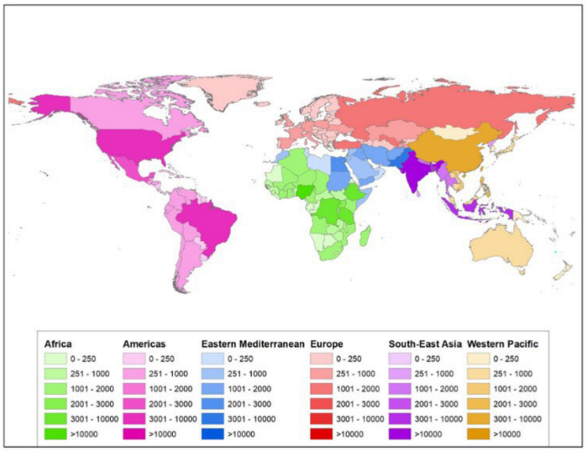
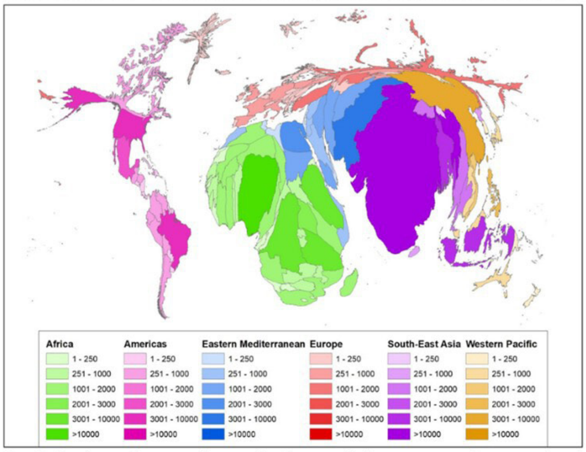


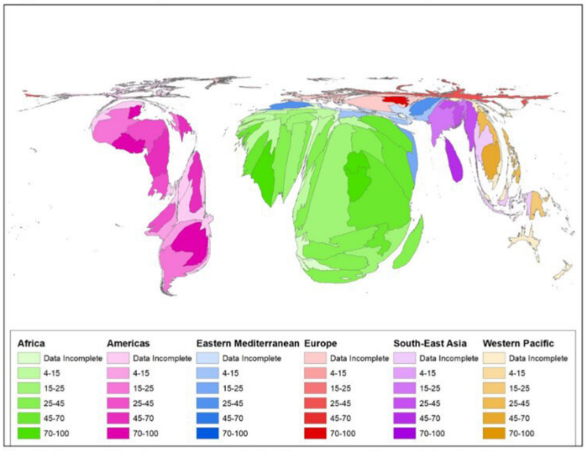
**Figure 4** Age at enrolment.



**Map 1: Numbers of expected clubfoot cases, all countries, conventional map view**



**Map 2: Numbers of expected cases (land mass relative to expected case numbers)**



**Map 3: Percent treatment coverage in 70 respondent countries, land mass relative to coverage**

**Figure 5** Cartograms show: 1. Conventional map view with expected numbers of clubfoot cases per country per year, 2. Land mass proportional to expected number of children born with clubfoot and 3. Land mass proportional to treatment coverage in 2023.

reported 80%–90% of children receiving tenotomy. 18 countries had the highest rates, with 90%–100% of children undergoing the procedure (online supplemental table 2).

67% of children received their first foot abduction brace. The distribution of brace fitting varied by country: 3 countries had only 0%–25% of children fitted with the brace, 7 countries had between 26% and 50%, 21 countries fitted between 51% and 75% and 29 countries achieved a fitting rate of 76%–100% (online supplemental table 3).

Across all LMICs, the coverage reached 18%, with 83% of the expected cases included in the data collection. Coverage of clubfoot services varied across different income groups and WHO regions and highlights global disparities in access to treatment. For low-income countries, 9636 children were enrolled out of an expected 30929 cases (31% coverage). In lower-middle-income countries, 18647 children were enrolled out of an expected 92,696, which translates to a 20% coverage rate. Upper middle-income countries showed the lowest coverage rate of 10%, with only 1335 children enrolled out of an expected 13807 cases. These disparities are further illustrated in figure 5, where resized maps show the relative land masses of countries according to the number of children born with clubfoot and the extent of service coverage. 15 countries achieved treatment coverage of 50% or more, including Armenia, Belize, Burundi, Dominican Republic, El Salvador, Guinea-Bissau, Guyana, Kenya, Liberia, Malawi, Paraguay, Rwanda, Sierra Leone, Sri Lanka and Tanzania.

57 countries scored their integration of clubfoot services within the health system (maximum score of 69). The mean score was 48%. Six countries scored between 0% and 25%, indicating that these countries have minimal integration of clubfoot services. Conversely, one country achieved a high score of 64 (93% integration). Most countries (n=37) had integration proportions between 26% and 50%, while 13 countries had a higher range of 51%–75% (online supplemental table 4). This variation highlights the differences in service availability and coordination for clubfoot treatment across different regions.

The categories of integration that scored the highest were (1) foot abduction braces available when needed, (2) foot abduction braces of a high quality, (3) foot abduction braces free, subsidised or have low fees and (4) a local team is in place and available to train new providers. The lowest scoring categories were (1) treatment materials (casting and tenotomy supplies) provided by the government and readily available and (2) the Ponseti Method is included in relevant preservice curricula (at universities and educational institutions).

## DISCUSSION

We aimed to evaluate the current global landscape of clubfoot management, focusing on treatment coverage and identifying service provision strengths and gaps. Our findings contribute to the literature on scaling up services for congenital conditions. The low global coverage rate of 22% in respondent countries and 18% in all LMIC, uneven distribution of care across regions and variability in quality and sustainability indicators suggest that, despite global initiatives like RunFree2030,[17] barriers remain in scaling up clubfoot services. Nevertheless, 17 countries reached 50% coverage or higher, and there is a strong upwards trajectory over time in the number of cases enrolled for treatment each year. Data from 70 countries, covering 83% of expected cases in LMICs, revealed that 40 718 children were enrolled for Ponseti treatment in 2023. Cartogram modelling showed a global disparity between areas with the highest burden of expected cases vs those where treatment services are concentrated. Of those enrolled, 73% were under 1 year old, showing a positive trend towards starting treatment early, which is key to successfully managing clubfoot. This trend may partially be attributed to effective awareness campaigns, early detection and referral practices and the use of GCI member resources such as the Clubfoot Early Detection and Adherence programme.[25] Stagnation in coverage rates between 2019 and 2021 reflects the impact of the COVID-19 pandemic on healthcare access and service delivery.

This study provides valuable data that can inform efforts to strengthen health systems and ensure that interventions for children with congenital conditions are effectively implemented and scaled within existing healthcare frameworks. For example, increased awareness, newborn screening and early detection and referral, access to treatment and assistive technologies are essential to improving treatment outcomes and ensuring that all children receive timely care.[16] This approach requires expanding screening programmes and early detection networks.[26] Nurses, midwives, skilled birth attendants and community health workers should be trained to (1) recognise conditions at birth; (2) educate parents on congenital conditions to reduce stigma, misinformation and risks of abuse or neglect and (3) refer children for health services.[16] Their role strengthens the care pathway for all early childhood impairments, benefiting not only affected children but others as well.

Strengthening the health system involves not only increasing the number of clinics and services available but also ensuring these clinics provide high-quality care.[27] For example, approximately half of the countries provide sufficient care to correct the initial clubfoot deformity (deformity corrected within 8 casts in 54%, n=33/61; tenotomy rate of over 80% in 46%, n=29/63) and only 67% of children receive their first brace, despite high integration scores for providing assistive products. These data highlight the importance of good monitoring and supervision with ongoing mentoring within clubfoot clinics, effective clinical training and reliable supply chains to ensure quality services. Monitoring data may also assist in improving services for clubfoot by identifying gaps in care delivery. For example, the discrepancies in availability of braces and fitting of the first brace may be due to several factors. In some countries, braces are expensive, and parents cannot afford them.[28] There may also be limited understanding as to why a brace needs to be worn once a child's foot looks better.[29] Some clinics do not have a regular supply of good quality braces, especially in countries with inadequate or poorly integrated assistive technology supply chains.[30] These findings underscore the need for more targeted interventions to ensure that foot abduction braces are consistently accessible, affordable and of high quality, and that healthcare providers are equipped to educate and support families in adhering to the full treatment regimen.[31]

Our findings also align with broader literature on the difficulties of providing continuous and high-quality care in low-resourced settings,[32] where healthcare systems are often underfunded,[33] and the availability of trained healthcare providers is limited.[34–36] Many countries had national programmes for clubfoot, often through public–private partnerships, although with low reported government support for treatment supplies. Our study underscores the need to integrate clubfoot treatment within broader health services to improve early detection and access to care. This focused approach should ensure that policies, treatment guidelines and clinician training are adopted and implemented consistently. Key actions include mainstreaming early detection and referral through newborn screening, strengthening supply chains for treatment materials, integrating relevant training into healthcare curricula and developing robust data collection systems to track and improve treatment quality. By addressing these systemic gaps, from diagnosis through treatment and follow-up, we can ensure a more comprehensive continuum of care, which is critical for improving long-term outcomes for children with clubfoot.

One of the key strengths of this study is its comprehensive coverage, with data from 70 countries accounting for 83% of expected cases in LMICs. The use of a standardised form and the involvement of national clubfoot programme coordinators and practitioners ensure that the data are representative and relevant. There are limitations to be considered when interpreting the results. First, the study relies on self-reported data, which may introduce bias or inaccuracies. The low percentage of children receiving their first foot abduction brace, for example, may reflect inconsistencies in reporting or gaps in data collection. Second, the study does not account for countries where there is known treatment activity but limited available data, such as China and Brazil. This may underestimate the true coverage of clubfoot services, particularly in upper-middle-income countries. Third, the impact of COVID-19 on healthcare delivery and data collection cannot be fully quantified. Finally, the study's focus on lower-income and lower-middle-income countries means that it may not fully capture the challenges and successes in upper-middle-income countries, where fewer Non-Governmental Organisations (NGOs) are active, data collection may be less coordinated, and treatment may be provided outside of the national health system.

These findings have implications for policy, programmes and research. There is a need to integrate clubfoot care into broader maternal and child health services and primary care. This approach should mainstream birth defect surveillance into regional and national protocols. Integration will be aided by routine education for healthcare providers who are assigned to clubfoot clinics in both preservice and postgraduate training, as well as legislation and budgets to adequately resource services, to ensure that early diagnosis and treatment are part of routine healthcare. The low percentage of children receiving their first foot abduction brace suggests that more attention is needed to ensure that all children enrolled in treatment receive the necessary follow-up care. Low brace and tenotomy rates may contribute to a higher risk of recurrence in treated clubfoot cases, which could place additional strain on the health system as more resources may be required for retreatment and managing complications of recurrence of the deformity. Improving quality care could involve learning from countries with high percentages of children receiving their first brace to develop and implement protocols for brace fitting, training healthcare providers and ensuring that families understand the importance of bracing in the treatment process. This study also provides evidence that applying best practices and replicating services across countries and regions can scale clubfoot services. However, it also highlights that, even with this progress, many babies with clubfoot in LMICs still do not receive treatment, supporting RunFree 2030's call to 'increase access to clubfoot treatment worldwide and prevent disability for over two million children born in the next decade.[17]'

Future research should focus on developing strategies to improve data collection in countries where treatment is known to occur but data are unavailable. Formalised roles, supervision and leadership, and targets are required for referral systems to work effectively. Adequate record keeping is crucial to track children who may be lost to follow-up, but complex paperwork or a lack of systems can make this difficult. Valid, reliable and timely data are essential for planning and delivering high-quality services, informing the distribution of clinics and healthcare workers, and improving national health systems. Future studies should also explore the reasons behind the low coverage rates and the barriers to scaling up clubfoot services.

There are opportunities to enhance global clubfoot services by leveraging WHO guidelines and frameworks, which influence government health spending, development assistance and target setting. For instance, with insufficient government-led investment in rehabilitation in LMICs, WHO's Rehabilitation 2030[37] initiative could focus on strategic areas such as newborn and child health to raise health sector awareness and integrate rehabilitation into primary care. Emphasising neonatal and paediatric rehabilitation would improve coordination among WHO's leadership in maternal, newborn, child, and adolescent health, human resources, essential surgical care, and the Global Cooperation on Assistive Technology.[38] Additionally, while the 2020 WHO birth defects surveillance manual[39] addresses crucial information gaps in surveillance, it would be beneficial to include comprehensive evidence-based care guidance in the Rehabilitation 2030 intervention package,[37] aligning it with the WHO and UNICEF's plan for improving newborn outcomes.[40]

## CONCLUSIONS

Progress has been made in global clubfoot management, but there are still challenges to overcome in reaching all children who need treatment. This study demonstrates that it is possible to scale up services in both numbers and quality. Achieving these improvements requires continued efforts to expand access to high-quality treatment and fully integrate clubfoot treatment into health systems worldwide. This study may serve as a model for addressing other congenital conditions within global health frameworks. By applying a similar approach to other conditions, it is possible to identify gaps in care, develop targeted interventions and integrate these into existing health systems, ultimately improving outcomes for children with congenital conditions worldwide.

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**Data availability statement** Data may be obtained from a third party and are not publicly available.

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