The global birth prevalence of clubfoot: a systematic review and meta-analysis

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Summary

Background Estimates of the birth prevalence of clubfoot in low and middle income settings range from 0.5 to 2 per 1000 births. However, there is currently no estimate of global birth prevalence of clubfoot.

Methods We conducted a systematic review of studies reporting the birth prevalence of clubfoot across all countries and regions worldwide in the last 10 years. Africa Wide Information, EMBASE, CINAHL, Global Health, LILACS and Medline databases were searched for relevant studies from January 1st 2012 to February 9th 2023. Pooled prevalence estimates were calculated using the inverse variance method, and a random effects model was applied to account for heterogeneity between studies. Quality appraisal was performed using a modified Newcastle–Ottawa Quality Assessment Scale for Cohort studies. This review was registered with PROSPERO, CRD42023398410.

Findings The search generated 757 studies. Thirty-five studies from 36 countries and five WHO regions were included. The pooled prevalence of clubfoot was 1.18 per 1000 births (95% CI: 1.00–1.36) based on data from 44,818,965 births. The highest prevalence rates were observed in low- and middle-income countries, particularly in the South-East Asia Region (1.80, 95% CI: 1.32–2.28) and the Africa Region (1.31, 95% CI: 0.86–1.77). We estimate that 176,476 (95% CI: 126,126–227,010) children will be born with clubfoot globally each year.

Interpretation This study provides a comprehensive estimate of the global prevalence of clubfoot and highlights the significant burden of this condition, particularly in low- and middle-income countries. The findings underscore the need for improving access to effective treatment and prevention strategies in resource-limited settings.

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Keywords: Clubfoot; Congenital talipes equinovarus; Birth defects; Congenital anomalies; Birth prevalence; Global; Meta-analysis; Systematic review

Introduction

Congenital conditions were the 10th most important cause of loss of health globally in 2019.[1] Clubfoot, also known as congenital talipes equinovarus, is one of the common congenital conditions that causes mobility impairment in children.[2] The structure and position of the foot are affected and the foot is fixed in a downward and inward position, leading to pain and reduced mobility if left untreated.[3] This can result in limitations in participating in activities and overall disability.[4] However, the Ponseti method is widely recognized as an effective conservative treatment approach for clubfoot that avoids corrective surgery in over 90% of cases.[5] It involves a series of gentle manipulations and the application of plaster casts to gradually correct the foot deformity. Subsequently, a percutaneous Achilles tenotomy is usually performed to correct the downward position of the foot, followed by the use of a foot abduction brace to maintain the corrected position and prevent relapse.

The causes of clubfoot, in most cases, are unknown, although literature on clubfoot is increasingly linked to genetic and environmental factors.[6] Epidemiological studies show higher birth prevalence of clubfoot in

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Research in context

Evidence before this study

We conducted a search on PubMed on January 15th, 2023, which yielded one meta-analysis published in 2015 by two of the current study authors, focusing on the birth prevalence of clubfoot in low and middle-income countries (LMICs). The meta-analysis found that the birth prevalence of clubfoot varied between 0.51 and 2.03 per 1000 live births in LMICs. However, this study did not evaluate the risk of bias in the included studies, or provide an overall assessment of the certainty of the evidence. Furthermore, we found no published estimations of the global prevalence of clubfoot. Subsequent primary research articles on clubfoot have been published since the meta-analysis, in both high and low income settings.

Added value of this study

This study advances the existing literature on the birth prevalence of clubfoot by integrating new global research. By conducting a comprehensive systematic review, we identified opportunities for standardising data collection and reporting in this field. Additionally, the research uncovered additional studies that couldn't be included in the meta-analysis due to limited information on birth denominators or inadequate measures of birth incidence. The robust methodology included risk of bias assessments and meta-analyses, revealing higher birth prevalence of clubfoot in the SEARO and AFRO regions, while highlighting the research gap in the EMRO and WPRO (excluding China) regions, where no studies on clubfoot birth prevalence were available.

Implications of all the available evidence

The analysis of data from 35 studies encompassing 36 countries and five WHO regions revealed a global birth prevalence of clubfoot of 1.18 per 1000 births, with a higher rate in LMICs, particularly in the South-East Asia and Africa regions. The findings emphasise the urgent need for improved access to effective treatment and prevention strategies, especially in resource-limited settings, to reduce long-term disability. Standardised data collection, the establishment and strengthening of birth registry databases, ensuring comprehensive coverage and accurate data collection, and, expanding research to underrepresented regions like EMRO or in countries outside of China in WRPO are vital for informed policy making to ensure that we 'leave no one behind'.

males and first-born children.[6] It is estimated that 80% of children born with clubfoot each year reside in low- and middle-income countries (LMICs).[7] To address this growing inequity, prioritising functioning from birth through early identification and intervention has been recommended as a strategic focus to strengthen rehabilitation systems and policies, particularly in countries with fragmented health systems.[2] Early detection through screening programmes is critical, not only for developmental outcomes but in determining whether children have access to early intervention and rehabilitation at all.[8] Valid, reliable and timely data on the birth prevalence of congenital conditions is therefore essential for effective healthcare planning, resource allocation, and delivery of high-quality early intervention services.[9] It allows healthcare systems to tailor services to meet the specific population needs, detect trends and patterns in congenital conditions for timely interventions, and address disparities in healthcare provision. Yet, there are no global estimates for clubfoot birth prevalence.

An improved understanding of the global birth prevalence of clubfoot is needed to inform public policy, health planning, and allocation of limited healthcare resources for early intervention and treatment. Global estimates may be used to identify disparities in access to care and the distribution of healthcare resources, as well as to gain insights into the burden of this condition. We therefore undertook an updated systematic review and meta-analysis to assess the extent and quality of data for children with clubfoot worldwide.

Methods

Study design

The systematic review was performed following MOOSE guidelines and aimed to estimate the global birth prevalence of clubfoot in the last 10 years. The study was registered with PROSPERO number CRD42023398410. We followed PRISMA reporting guidelines.[10] Institutional ethics and informed consent were not required due to the nature of the study design.

Search strategy and selection criteria

We systematically searched Africa Wide Information, EMBASE, CINAHL, Global Health, LILACS and Medline on February 9th 2023. We included the period from January 1st 2012 to February 9th 2023 to identify available evidence on clubfoot birth prevalence. Studies in all languages were included. We included published prospective and retrospective cohort studies and cross-sectional studies, with a baseline assessment of live births and assessment of the outcome (clubfoot).

The article titles and abstracts returned from the search were screened independently by two reviewers, and references from the included studies were also checked for relevance. The full texts were reviewed independently by two reviewers, with any differences resolved through discussion. The search strategy is

summarised in Supplementary Table S1, and the internet-based systematic review management software Raayan.ai was used.

Data screening and extraction

Two authors independently selected articles to identify relevant evidence. TS and SR screened all titles and abstracts using predetermined eligibility criteria, and independently evaluated full-text articles for inclusion. Any discrepancies were discussed and resolved at each stage until consensus was reached.

The definition of clubfoot was established as a rigid abnormality where the foot is positioned in a plantarflexed, supinated, and adducted manner. To be eligible for this systematic review, the study had to meet the following requirements: (1) original research on clubfoot, (2) investigation conducted to determine of birth prevalence of clubfoot, (3) screening of all children for clubfoot, and (4) published between 2012 and 2023. Exclusion criteria included: (1) unavailability of the full text, (2) unclear screening of all children for clubfoot, (3) unclear definition of the source population and the denominator, and (4) duplication of reports from the same study.

A structured data extraction tool was developed and pilot-tested in MS Excel, to systematically record relevant information from the included studies. The extracted information included: publication characteristics (author, title, year of publication, and setting/country), study design (data source and sample size), participant characteristics, population comparator characteristics and outcomes (birth prevalence of clubfoot). When a study was eligible for inclusion in the review, the numerator and denominator were verified and the prevalence estimate was recalculated, where necessary (i.e., converted from per 10,000 live births to per 1000 live births). For studies that did not include 95% confidence intervals, the Wilson Score was calculated using the population and number of clubfoot cases.[11] The data extraction was conducted independently by the two reviewers, with any discrepancies discussed and resolved. Studies that were excluded at full text stage were assigned reasons for exclusion.

Risk of bias assessment

The two investigators graded the overall certainty of the evidence using the Newcastle–Ottawa Quality Assessment Scale (NOQAS) for Cohort studies (Supplementary Table S2),[12] and compared scores to reach an agreement. Included studies were graded as low, medium and high risk of bias. Since the NOQAS tool focuses on cohort studies and most studies included were descriptive, we modified the checklist to exclude the comparability criteria. This modification aligns with previous studies that have followed a similar approach.[13–15] Total scores range from 0 to 7. For the total score grouping, studies were judged to be of low risk of bias (≥6 points), medium risk (5 points) or high risk of bias (<5 points). Results are summarized in Supplementary Table S3.

Data synthesis and meta-analysis

The data were assumed to report the number of live births per 1000 unless otherwise specified as including stillbirths. The birth prevalence of clubfoot was calculated based on the number of babies born with clubfoot and the total population in each study. Pooled prevalence was estimated in Review Manager (version 5.4) software using the inverse variance method. Due to the high heterogeneity between studies ($I^2 > 95\%$, $p < 0.05$) the meta-analysis was conducted using a random-effects model to estimate the weighted summary measures for different WHO regions. The p-value is from the chi-squared test. The weight assigned to each study was based on its effect size, determined by its inverse variance. The results were displayed on a forest plot.

Change to the prospero registered strategy

The estimated number of cases born per million total population per year was calculated in R (version 4.2.3) using the regional clubfoot birth prevalence and the population at age 0 data from UN data for births.[16]

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Search results

The search identified 757 articles, and an additional 3 studies were identified in the screening process through reference checking. After 229 duplicates were removed, 528 abstracts were screened and 471 articles were excluded at the title/abstract screening stage as they did not meet eligibility criteria. The remaining 57 full texts were evaluated for eligibility, of which 32 were found to be eligible for inclusion (Fig. 1). The reasons for the exclusion of the other 25 full texts are detailed in Supplementary file S4.

Study characteristics

In total there were 44,818,965 births. The largest study comprised of 9,152,674 births,[17] whilst the smallest study had 1551 births.[18] Of the 35 eligible studies, 13 (37%) were conducted in high income countries (Canada, France, Netherlands, Norway, Sweden, Canada, UK, USA and a subset of 21 countries from the EUROCAT database) and 22 (63%) were undertaken in low and middle income countries (India, China, Italy, Argentina, Thailand, Uganda, Nigeria, South Africa and LAC countries). No studies meeting our inclusion criteria were found for the Eastern Mediterranean

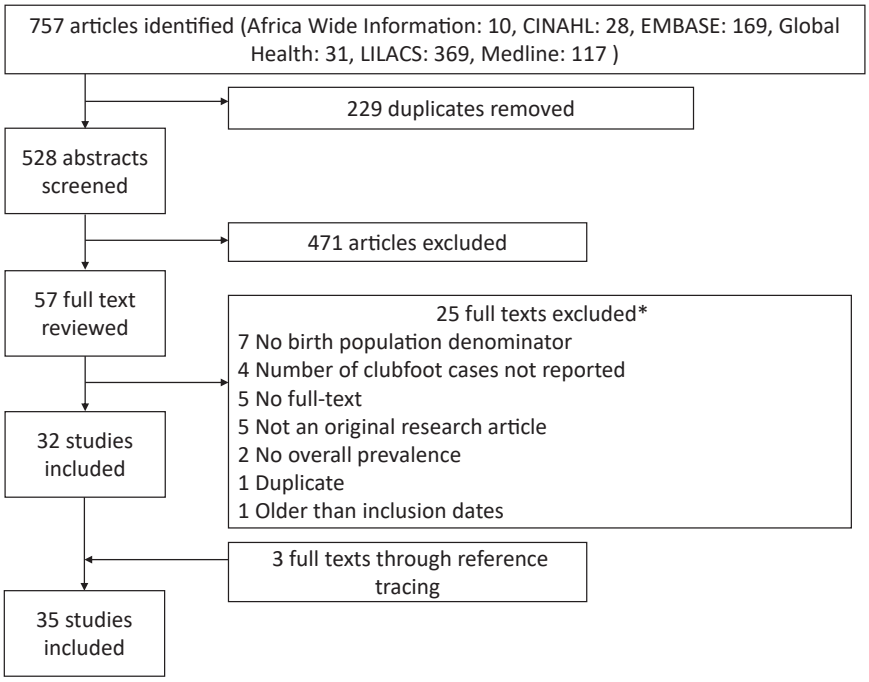

Fig. 1: PRISMA diagram for search strategy.

Region. The Western Pacific Region was solely represented by China (n = 9), while the South East Asia region was represented by studies from India (n = 5) and Thailand (n = 1). Half of the studies utilised birth defect monitoring databases, with the remaining studies being undertaken in hospital or clinic settings (n = 17, 47%) and the community (n = 1, 3%). Over half of the studies did not provide a definition of clubfoot (n = 18, 51%). Clinical examination was the primary method for case ascertainment and was supplemented by ultrasound investigations in 2 studies. The majority of studies (n = 33, 94%) were assessed as having a low risk of bias (Tables 1 and 2).

Birth prevalence of clubfoot

Of the 44,818,965 births registered globally, there were 35,554 children identified with clubfoot in the included studies. The pooled prevalence of clubfoot was 1.18 per 1000 births (95% CI: 1.00–1.36). The highest prevalence rates were observed in low- and middle-income countries, particularly in the South East Asia Region (1.80, 95% CI: 1.32–2.28) and the Africa Region (1.31, 95% CI: 0.86–1.77) (Fig. 2).

The estimated figures for clubfoot management planning in different populations, considering the birth rate per million population and accounting for the specific birth rates within each population in the respective WHO regions, are presented in Fig. 3. In the case where region-specific estimates for clubfoot birth prevalence in the Eastern Mediterranean Region Office were unavailable, global prevalence estimates were utilised as the regional estimate instead. The meta-analysed studies from China were taken as representative of WPRO, though we note that this may not be fully representative of the situation across the region.

We estimate that 176,476 (95% CI: 126,126–227,010) children will be born with clubfoot globally each year. Approximately 60,307 children with clubfoot will be born in the South East Asia Region and 51,874 in the Africa Region. To facilitate effective planning, we

Variable		N (%)
Country setting	High income countries	13 (37)
	Low- and middle-income countries	22 (63)
Study setting[a]	Hospital or clinic	17 (47)
	Birth defect monitoring databases	18 (50)
	Community setting	1 (3)
Ascertainment of clubfoot	Clinical examination	15 (43)
	Medical records	6 (17)
	Data extracted from database	9 (26)
	Not described	5 (14)
Risk of bias rating	High risk	1 (3)
	Medium risk	2 (6)
	Low risk	32 (91)

[a]Studies used more than one setting.

Table 1: **Study characteristics for included studies.**

Primary author (date)	Country	WHO Region	Study time	Setting	Method of case ascertainment	Clubfoot definition	Population (n)	Clubfoot (n)	Female (%)	Birth prevalence	Risk of bias
Agrawal (2014)[19]	India	SEARO	2010–2011	Hospital	Physical exam	Not reported	7268	15	Not reported	2 (1.25–3.40)	Low
Besselaar (2018)[20]	Netherlands	EURO	2013–2014	Accredited clubfoot treatment centres	Medical records	diagnosis treatment codes	346,522	377	34.20%	1.09 (1.01–1.2)	Low
Bhide (2018)[21]	India	SEARO	1960–2015	52 hospital based, 3 community-based	Not reported	Not reported	802,658	1694	Not reported	1.79 (1.51–2.07)	High
Chen (2018)[22]	China	WPRO	2011–2015	Hospital	ICD-10 criteria	ICD-10 definition	260,722	315	Not reported	1.21 (1.07–1.34)	Low
Dodwell (2015)[23]	Norway	EURO	1998–2008	Medical birth registry	Medical records	ICD-10 Q66.0	107,673	121	36%	1.1 (0.92–1.32)	Low
Dolk (2016)[24]	21 EUROCAT[a] countries	EURO	1995–2005	Surveillance network	Medical records	Database-defined	6,300,000	5063	Not reported	0.8 (0.78–0.83)	Low
Esbjornsson (2021)[25]	Sweden	EURO	2016–2019	Swedish Pediatric Orthopaedic Quality Register (SPOQ)	Orthopaedic referral—physical exam	ICD0-10 code Q66	453,412	612	25%	1.35 (1.25–1.46)	Low
Groisman (2017)[26]	Argentina	PAHO	2009–2013	Hospital-based surveillance system	Physical exam	ICD-10 Q66.0 and Q66.1	703,325	484	Not reported	0.69 (0.63–0.75)	Low
Groisman (2018)[27]	Argentina	PAHO	2016	National hospital-based database	Physical exam (birth until discharge)	Not reported	305,452	196	Not reported	0.64 (0.55–0.74)	Low
Jarurantanasirikul (2016)[28]	Thailand	SEARO	2009–2013	Birth register	Physical exam	ICD-10 definition	186,393	187	Not reported	1 (0.87–1.20)	Low
Kumari (2018)[29]	India	SEARO	2014–1016	Hospital	Physical exam	Not reported	10,126	33	33.30%	3.25 (2.15–4.37)	Low
Lane (2017)[30]	Canada	PAHO	1988–2013	Database	Physical exam after birth or at the time of discharge	Not reported	258,147	629	Not reported	2.4 (2.20–2.60)	Low
Li (2013)[31]	China	WPRO	2008–2010	4 Counties in Hengyang Province	Physical exam, cluster sampling survey	Not reported	52,307	50	Not reported	0.96 (0.73–1.26)	Low
Mai (2019)[32]	USA	PAHO	2010–2014	Surveillance network	Discharge diagnostic exam	Not reported	5,186,504	6756	Not reported	1.69 (1.27–1.33)	Low
Marengo (2013)[33]	USA	PAHO	2005–2008	Surveillance network	Physical exam at time of delivery	Not reported	1,597,541	2272	Not reported	1.42 (1.36–1.48)	Low
Morris (2018)[34]	25 EUROCAT[a] countries	EURO	2003–2012	Surveillance network	Medical records	ICD-10 definition	Not reported	Not reported	Not reported	1.08 (1.06–1.11)	Low
Mumpe-Mwanja (2019)[35]	Uganda	AFRO	2015–2017	Birth defects surveillance system	Physical exam by trained midwife	ICD-10 definition	69,766	98	Not reported	1.40 (1.15–1.71)	Low
Orioli (2020)[17]	8 ReLAMC[b] countries	PAHO	2017–2019	Surveillance network	Not described	ICD-10 definition	9,152,674	2341	Not reported	0.26 (0.25–0.28)	Low
Orimolade (2014)[18]	Nigeria	AFRO	2012	Hospital	Physical exam	Not reported	1551	5	50% (7/22 with CBDs)	3.22 (1.38–7.52)	Low
Pavone (2012)[36]	Italy	EURO	1991–2004	Register	Not described	Not reported	801,324	827	32.30%	1.03 (0.8–1.2)	Low
Pullinger (2014)[37]	UK	EURO	2007–2012	Hospital	Ultrasound scan and clinical history after birth	Not reported	34,373	67	Not reported	1.2 (1.54–2.47)	Medium
Rittler (2021)[38]	Latin American Countries	PAHO	2005–2018	Hospital surveillance	Diagnosis at birth or at discharge	ICD8 and ECLAM codes	965,473	1274	Not reported	1.32 (1.30–1.4)	Low
Sachdeva (2014)[39]	India	SEARO	2010	Hospital	Physical exam	Not reported	Not reported	8	43.90%	2.79	Medium

(Table 2 continues on next page)

Primary author (date)	Country	WHO Region	Study time	Setting	Method of case ascertainment	Clubfoot definition	Population (n)	Clubfoot (n)	Female (%)	Birth prevalence	Risk of bias
(Continued from previous page)											
Sinha (2022)[40]	India	SEARO	Not reported	Hospital	Physical exam	ICD-10 definition	8047	34	Not reported	4.23 (3.03–5.90)	Low
Sirsikar (2015)	India	SEARO	2011–2014	Hospital	Not described	Not reported	118,654	98	37%	0.8 (0.68–1.00)	Low
Stoll (2020)[41]	France	EURO	1979–2007	Congenital malformation register	Physical exam and genetic testing	ICD-10, code Q66.0	387,067	504	35%	1.03 (1.2–1.4)	Low
Thiart (2022)[42]	South Africa	AFRO	2014–2018	Hospital	Not described	Not reported	159,348	162	36.50%	1.02 (0.87–1.19)	Low
Toufaily (2014)[43]	United States	PAHO	1972–2012	Hospital	Physical exam	ICD-10 code Q66	311,480	208	Not reported	0.67 (0.58–0.77)	Low
Wang (2014)[44]	China	WPRO	2011–2013	Hospital surveillance system	Review birth defects registry forms and perinatal infants quarterly report	Not reported	118,199	62	Not reported	0.52 (0.41–0.67)	Low
Wang (2019)[45]	18 EUROCAT countries	EURO	1995–2011	Surveillance network	Medical Records	CD 9 code 75,450 or ICD 10 code Q660	4,840,588	5458	35%	1.13 (1.10–1.16)	Low
Weihong (2014)[46]	China	WPRO	2011–2013	Hospital surveillance	Data from monitoring institutions	Not reported	87,059	53	Not reported	0.61 (0.47–0.80)	Low
Xie (2021)[47]	China	WPRO	2016–2019	Hospital surveillance	Prenatal screening	Maternal and Child Health Monitoring Scheme	2,883,890	32	Not reported	0.012 (0.007–0.016)	Low
Yang (2015)[48]	China	WRPO	2003–2009	Database	Review of birth defects surveillance network	Not reported	191,017	137	Not reported	0.72 (0.61–0.85)	Low
Yi (2013)[49]	China	WRPO	2001–2010	Database	Birth defects monitoring programme	Not reported	8,273,382	4233	Not reported	0.51 (0.50–0.53)	Low
Zhou (2020)[50]	China	WPRO	2014–2018	Database	physical exam	ICD-10	28,040	100	Not reported	3.57 (2.93–4.34)	Low

[a]EUROCAT: European network of population-based registries for the epidemiologic surveillance of congenital anomalies. [b]ReLAMC: Latin American network of congenital malformation surveillance.

Table 2: **Study characteristics and estimated birth prevalence.**

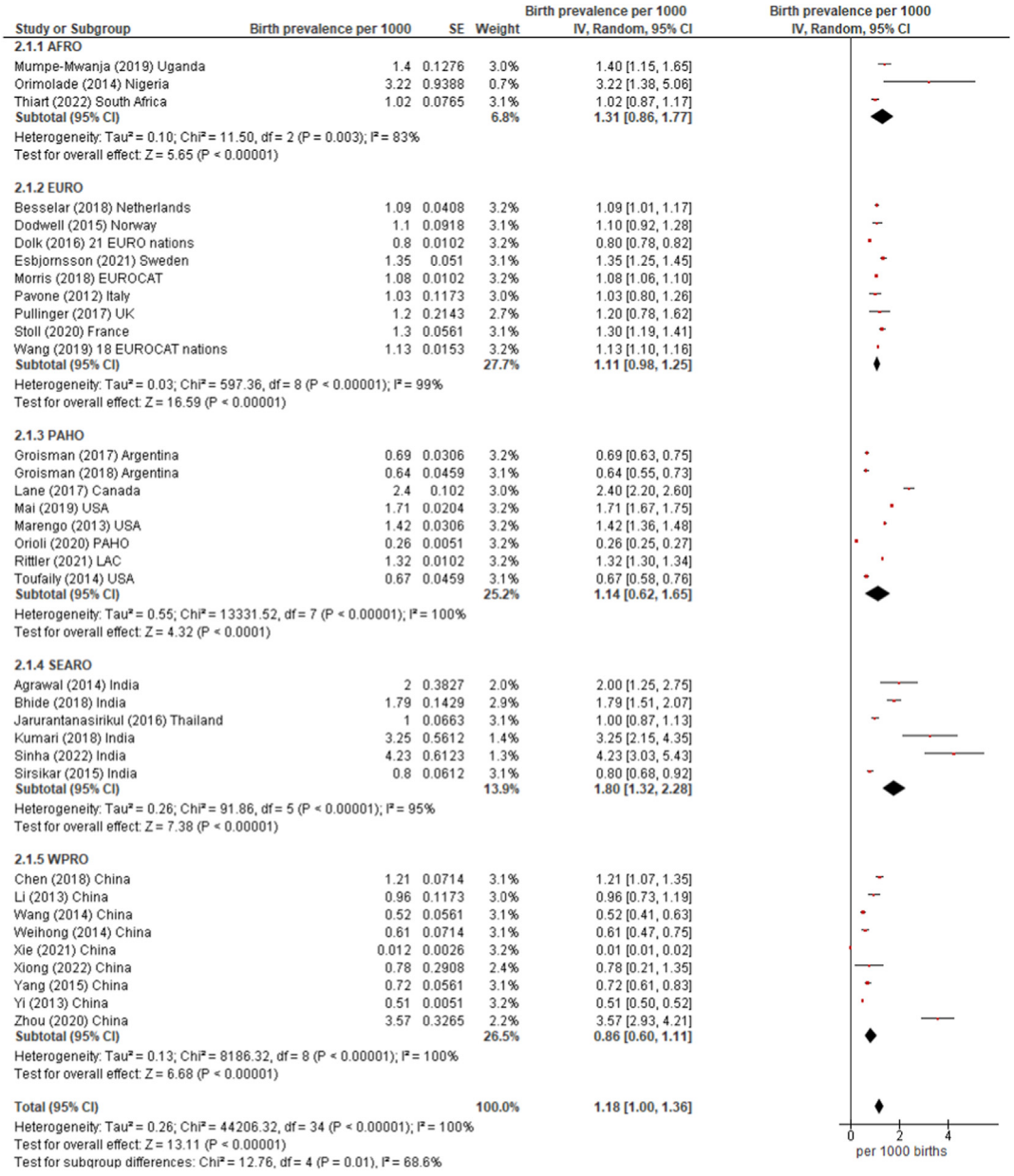

Fig. 2: Pooled global birth prevalence of clubfoot.

recommend applying regional estimates of clubfoot birth prevalence to the specific birth rates of each country, ensuring a more accurate and tailored approach to clubfoot management.

Discussion

This is the first systematic review to estimate the global prevalence of clubfoot. The results from 35 studies included 36 countries, five WHO regions, and 44,818,965 births. The pooled prevalence of clubfoot was 1.18 per 1000 births (95% CI: 1.00–1.36) and showed a range of birth prevalence from 0.86 per 1000 live births in the Western Pacific Region to 1.80 per 1000 births in the South-East Asia Region. Pooled estimates of birth prevalence rates appeared to be similar in the European and Pan American Regions. We estimate that 176,476 (95% CI: 126,126–227,010) children will be born with clubfoot globally each year.

Multiple factors may explain the variation in birth prevalence estimates observed between countries and regions in this study. All of the included studies

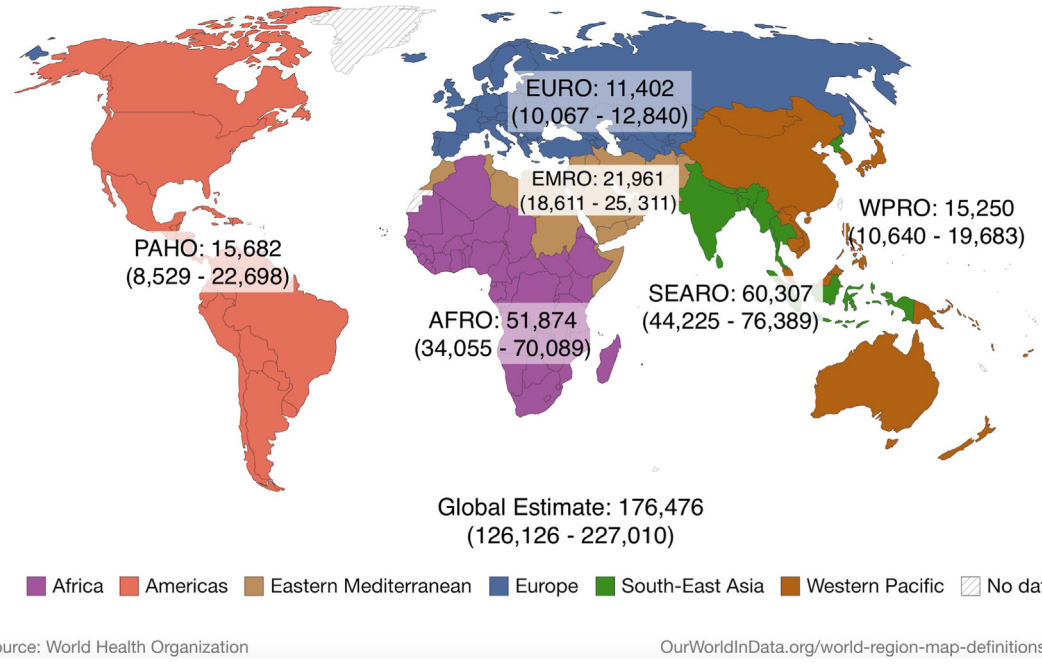

Fig. 3: Estimated number of Clubfoot Births by WHO region (95% confidence interval).

reported case definitions of clubfoot, however, not consistently. For example, some relied exclusively on ICD-10 code Q66.0, while others included Q66.1 or physical exams, rather than diagnostic codes. Therefore, despite individual study approaches to ensure comparable clubfoot definitions, there may have been incomplete data included. There were also differences in study design and data collection methods. Some countries lack rigorous congenital anomaly surveillance programs, which makes calculation of birth prevalence difficult, and there was a discrepancy according to country income level and region, with most of the studies from these types of sources being higher income countries. Estimates from LMICs range from 1 in 555 births to 1 in 1162 births,[7] and these are likely underestimated due to stigma and exclusion, as well as variability in case definition and screening methods. This systematic review suggests some variation in the birth prevalence of clubfoot, but the range of birth prevalence rate of clubfoot is similar to those reported in low- and middle income countries.[7] Our global estimates are therefore likely to be under-estimated. However, readers need to interpret the prevalence of clubfoot within their particular context because of the variation in how congenital conditions are identified and integrated into the health care system, which may not be uniform across and even within settings. For instance, many site-based analyses included only hospital-based births, but this may omit other facility or home-based births, depending on the sophistication of the surveillance system. This has substantial implications for the health system, as these children may have delayed identification and access to early intervention. When results show heterogeneity among included studies, as ours do, it can be concluded that effect size varies between studies, either due to methodological diversity or a true variation in birth prevalence. In this situation it is prudent to consider potential causes of heterogeneity and whether study differences are of a magnitude that does not support combining global birth prevalence. In our study, variation found between studies might arise from differences in practice between study settings resulting in higher or lower rates of reporting cases and the overall number of births (denominator) among studies. For example, complete medical records may be more or less available dependent on setting. It may also relate to population characteristics. We used the random effects approach to combine the effect sizes among studies to reflect these potential differences in study populations. Despite I^2 values indicating substantial heterogeneity in point estimates between studies, we are confident in our systematic review results. Reasons for this confidence include careful study selection based on inclusion criteria, consistent direction of effect, robust statistical methods, high quality of individual studies, and contextual considerations. These factors contribute to a comprehensive evidence assessment, allowing for nuanced interpretation of results and increased confidence, despite observed heterogeneity.

In 2020, the WHO published guidelines on standards for improving quality of care for newborns in health facilities[51] recommending assessing and

managing all newborns for congenital conditions. Additionally, updated guidance for screening and reporting of congenital conditions was provided[3] This is important because approximately 6% of live births are affected, with the majority occurring in low- and middle-income countries[52] where underreporting and inadequate treatment are prevalent, despite the potential for improvement with appropriate healthcare.[53] Nine congenital conditions benefit from early rehabilitation and provision of assistive technology.[2] Among these conditions, clubfoot has one of the highest birth prevalence. Other conditions include limb reduction (0.5–0.7/1000 births), spina bifida (0.06–2.89/1000 births), cleft lip and cleft palate (0.6/1000 births), cleft lip alone (0.35/1000 births), cleft palate alone (0.6/1000 births), microcephaly (0.046–0.585/1000 births), microtia and anotia (0.05–0.33/1000 births), and encephalocele (0.01–2.65/1000 births).[2]

A strength of this study is the relatively large population denominator in five WHO regions, which includes all categories of structural clubfoot. Our study is the first systematic review and meta-analyses of high quality studies reporting on the global prevalence of clubfoot. We included only those studies that met our a priori defined inclusion and exclusion criteria, and used an inclusive strategy with regards to data collection methods. Data were excluded from clinics where it was not clear how many babies were examined and did not have clubfoot, as birth prevalence cannot be calculated without a denominator. However, this review is limited by the representation of the available data from included studies and the heterogeneity in study design and data collection methods may have influenced the results. The NOQAS is a valuable tool for assessing observational study quality, given its adaptability to various research topics and validation for case–control and longitudinal studies. However, using the modified tool for birth prevalence with a minimum 6-month follow-up period may introduce bias in scoring papers as low risk. In addition, we did not apply any normalizing transformation to the data, despite the small proportion of prevalence, which may have affected the assumptions of the inverse variance method.

The results of this study have important implications for policy and practice. The estimated birth prevalence of clubfoot from this review can be useful for planning services and estimating areas of need for country programs. Screening at birth for clubfoot is important for early detection and treatment, as treatment is most effective when initiated early.[54] Scaling up appropriate services for screening and treatment should be a priority,[2] nurses, midwives, skilled birth attendants and community health workers need to be trained in their roles to recognize the condition from birth, provide appropriate parental education and refer to treatment centres. Future studies should ensure clear case definition and robust screening methods to allow for comparison of epidemiological data.

Clubfoot is a relatively common condition that should be detected at birth to optimise intervention and outcomes. When comparing prevalence figures for congenital malformations from different parts of the world, it is important to have clear case definitions and comparable methods of data collection. The published data on clubfoot prevalence globally over the last 10 years is similar to estimates in low- and middle-income countries (LMICs) from the previous 55 years. The global pooled prevalence of clubfoot was found to be 1.18 per 1000 births (95% CI: 1.00–1.36), with a range of 0.9–1.8 cases per 1000 live births in different world regions.

Contributors

TS performed the search, reviewed the articles for screening, extracted the data and reviewed the quality appraisal. SR reviewed the articles for screening, the extracted data and lead the quality appraisal. TS and SR verified the underlying data. This extracted data was used for meta-analyses performed, and TS was responsible for this data that was used to perform the statistical analysis and wrote the first draft of the manuscript with input from SR and CL. All authors provided input on the writing of the manuscript. All authors read and approved the final version of the manuscript.

Data sharing statement

All data used for the study has been included in the manuscript and Supplementary materials.

Editor note

The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Declaration of interests

SR received funds from the Global Clubfoot Initiative and the Rhodes Trust. TS and CL declare no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.eclinm.2023.102178.

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