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SYSTEMATIC REVIEW OPEN ACCESS

Growth Monitoring of Children Under Five Years Using National Reference Charts Versus International Growth Standards, 2007–2023: A Systematic Review

Bancy Ngatia[1] | Linda Vesel[2] | Eric O. Ohuma[1]

[1]Faculty of Epidemiology and Population Health, London School of Hygiene & Tropical Medicine, London, UK | [2]Ariadne Labs, Harvard T. H. Chan School of Public Health, Brigham and Women's Hospital, Boston, Massachusetts, USA

Correspondence: Eric O. Ohuma (eric.ohuma@lshtm.ac.uk)

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Keywords: gestational age | growth charts | growth monitoring | INTERGROWTH-21st standards | nutritional status | public health | WHO child growth standards

ABSTRACT

Background: Growth charts are commonly used for monitoring attained size at a specified age relative to a population average considered to represent expected growth.

Objectives: To evaluate the impact of the application of international growth charts for children under five on common growth metrics when compared to national reference charts.

Search Strategy: We conducted a systematic literature search across five electronic databases: CINAHL Complete (EBSCOhost), EMBASE (Ovid), MEDLINE (PubMed), Scopus, and Web of Science.

Selection Criteria: Studies published in English between 2007 and 2023 that made comparisons between national reference charts and either INTERGROWTH-21st (IG-21st) or WHO Child Growth (WHO CGS) charts.

Data Collection and Analysis: Common growth metrics were compared using either z-scores or centiles. The prevalence of small- and large-for-gestational age, stunting, wasting, underweight, overweight, and obesity was compared when calculated using international standards versus national charts.

Main Results: We identified 1556 records, of which 314 were excluded as they were duplicates, 1069 after reading the title and abstract, 90 after reading the full texts, and 7 we could not retrieve the full texts. Z-score or centile values of local references were more often reported to be higher than values of WHO CGS when evaluating weight-, length-, or head circumference- for- age. Seven of 11 studies reported higher rates of small-for-gestational age, while four of five studies reported lower rates of large-for-gestational age using local references compared to IG-21st standards.

Conclusions: Meaningful differences exist in growth assessment between national and international charts that have implications for identifying at-risk infants.

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1 | Introduction

Human physical growth is characterised by changes in the size and shape of the body over time [1, 2]. These morphological changes are quantitatively assessed by taking anthropometric measurements such as height and weight [3]. An individual's growth potential can be associated with their country's social, economic, and environmental conditions [4, 5].

Growth monitoring is a practice applied for identifying those at greater risk of suboptimal growth compared to their healthy peers of the same age. The first 1000 days of life (from conception to 2 years) is a time of rapid growth and development and, therefore, a crucial period for growth monitoring and early detection of malnutrition [6]. Well established associations exist between nutrition, growth, and developmental outcomes in early life and growth outcomes in later life [1, 7, 8].

Growth charts are a useful screening tool for identifying suboptimal growth. Growth references are constructed from the subpopulations that they represent, whereas growth standards use an international sample for comparisons across populations [9]. There are currently two international standards for monitoring fetal, newborn, and child growth: (1) WHO CGS [10–12], and (2) IG-21st [13, 14]. IG-21st extends WHO CGS to capture fetal growth [15], newborn size by gestational age and sex [13], and preterm postnatal growth [14]. The use of inappropriate charts and practices can lead to misclassification of children based on growth, inefficient resource allocation by governments, and significant distress to caregivers [16–18].

We aimed to review and synthesise current evidence on the differences observed when local references or international charts are used for growth assessment and monitoring. To our knowledge, only one systematic review exists that compares differences between growth references and standards; that review was published in 2006 and only included studies making comparisons to WHO CGS [19]. In this paper, we provide a more comprehensive and up-to-date review of studies investigating differences across multiple anthropometric and nutritional indices when using local or national references compared to the two existing international standards of child growth (WHO CGS and IG-21st).

2 | Methods

This review was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [20, 21], PRISMA literature search extension [22], as well as the Synthesis Without Meta-analysis (SWiM) guidelines [23].

2.1 | Eligibility Criteria

Research articles were included if they (i) made comparisons between an international standard (WHO CGS or IG-21st, or both) and a local reference, (ii) were published after 2006 for comparisons between WHO CGS and a local reference, and (iii) were published after 2014 for comparisons between IG-21st standards and a local reference. The selection of articles by publication year was motivated by consideration for when the two international standards were released. Articles were excluded if they were not in English, had no full text available, or made chart comparisons in children with specific medical conditions.

2.2 | Information Sources and Search Strategy

A systematic literature search was conducted in five electronic databases: CINAHL Complete (EBSCOhost), EMBASE (Ovid), MEDLINE (PubMed), Scopus, and Web of Science. A search strategy was created based on the syntax for each database. To make the search more comprehensive, a multi-strategy search was implemented on the basis of three topics: (i) size or growth in relation to length/height, weight, or head circumference, (ii) size-for-gestational age, specifically preterm, small- or large-for-gestational age, and (iii) anthropometric or nutritional index, including length/height-for-age, weight-for-age, weight-for-length/height, underweight, stunting, and wasting. Thus, for each database, three separate searches were run, each corresponding to one of these topics. B.N. developed the initial search strategies in consultation with an experienced information specialist, and the final strategies were fine-tuned collaboratively with E.O.O. and L.V. An overview of the search strategies and results for chart comparisons according to the three defined topics is provided in Appendix S1.

2.3 | Data Management

The articles identified in the search were screened and managed using the review tool Rayyan [24]. The screening process involved first reviewing article titles and abstracts, followed by full texts for relevant studies. B.N. independently screened and reviewed the titles, abstracts, and full texts. In case of doubt, consensus on inclusion or exclusion was reached by discussion with E.O.O. and L.V. on a per article basis.

2.4 | Data Analysis

The specific outcomes compared included length/height-for-age (LHfA), weight-for-age (WfA), weight-for-length/height (WfLH), BMI-for-age (BMIfA), head circumference-for-age (HCfA), small-for-gestational age (SGA), large-for-gestational age (LGA), stunting, wasting, underweight, overweight, obesity, thinness, and malnutrition. The indices LHfA, WfA, WfLH, BMIfA, and HCfA were compared using either z-scores or centiles. Studies reporting differences in z-scores or centiles for a specific growth metric were plotted and disaggregated by sex, where applicable (Figures S1 and S2). The indicators SGA, LGA, stunting, wasting, underweight, overweight, obesity, thinness, and malnutrition were compared using classification or prevalence rates, whereby rates under the national and international charts were explored graphically (Figure S3).

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3 | Results

3.1 | Study Selection

The literature search identified 1556 records from five electronic databases. There were 314 (20.2%) duplicates removed prior to title and abstract screening. A further 1069 (68.7%) records were excluded following the review of titles and abstracts, resulting in 173 (11.1%) studies to be assessed for eligibility. However, seven of these studies could not be retrieved either due to access limitations or unavailability of the full text. A total of 166 studies were eventually retrieved for full text screening. Ninety studies were excluded after reading the full texts, resulting in 76 articles included for the review (Figure 1).

3.2 | Study Characteristics

The key characteristics of each study extracted are presented in Table S1. These included country, year of publication, study design, data collection method, sample size, age range, growth charts compared, chart construction methodology, and the main outcome(s) reported.

There were 71 single country studies and five multiple region studies [25–29]. The 71 single country studies originated from the following six WHO regions: African (5, 6.6%) [30–34], Eastern Mediterranean (11, 14.5%) [35–44], European (24, 31.6%) [45–68], Americas (8, 10.5%) [69–75], South-East Asian (11, 14.5%) [76–85], and Western Pacific (12, 15.8%) [86–98].

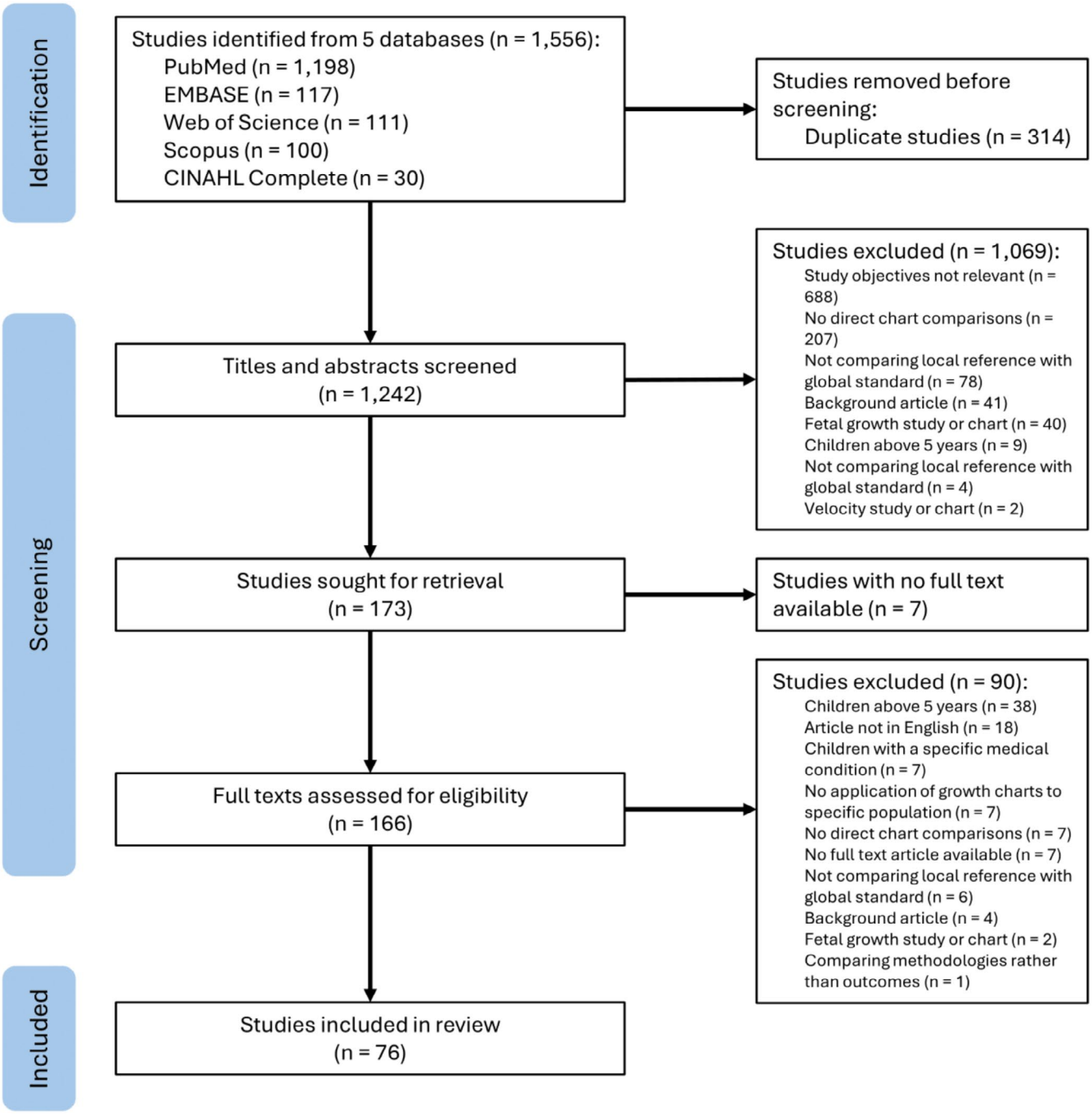

FIGURE 1 | Flow diagram for the identification, screening, and selection of studies from electronic databases.

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Table S2 shows the total number of studies by region, country, age ranges, and the types of charts compared. A total of 43 single country studies explored outcomes of children between 0 and 60 months old, while 28 studies focused on children 0–24 months old. Of the 71 single country studies, 74.6% (53 studies) compared local charts against WHO CGS, while 13 studies (18.3%) compared against IG-21st Newborn Size at Birth standards (IG-21st NS). Two studies made comparisons using both WHO CGS and IG-21st NS [33, 60], one study using IG-21st Preterm Postnatal Growth standards (IG-21st PPG) [62], one study using both IG-21st NS and IG-21st PPG [59], and one study using both IG-21st NS and IG-21st Very Preterm Size at Birth standards (VPS) [58].

More than half the total 76 studies compared outcomes in either length/height-for-age (43, 56.6%) or weight-for-age (46, 60.5%) and included separate charts for males and females (70, 92.1%). The number of studies per indicator and chart is shown in Figure 2.

3.3 | Local Charts Versus WHO Child Growth Standards

Studies in Argentina [70], India [76, 99], Indonesia [82], Malaysia [97], the Netherlands [50], and Turkiye [48] show that using the WHO standards resulted in more than double the prevalence of stunting, wasting, and underweight compared to local charts (Figure S3(C)–(E)). Conversely, in China [91], the prevalence of stunting and wasting was higher with the Chinese charts (17.2% and 4.4%, respectively) than with the WHO charts (16.1% and 3.0%, respectively).

3.4 | Local Charts Versus INTERGROWTH-21st Standards

In Sweden [67], assessment based on a local chart resulted in double the odds of mortality compared to using the IG-21st chart. In Poland [60] and China [89], infants had higher weight percentiles on average at birth when assessed using the respective local chart compared to IG-21st (Figure S2A,B). In Indonesia [81], the local chart classified more babies (both males and females) as SGA compared to IG-21st (3.4% vs. 2.6%) (Figure S3(A)).

3.5 | Anthropometric and Nutritional Status Indices

Table S3 presents the direction of effect when local reference chart values are compared to those of international standards. Local charts had higher z-scores or percentile values than international standards in 29 LHfA studies (67.4%), 26 WfA studies (56.5%), and 17 HCfA studies (89.5%). Conversely, local charts had lower values than international standards in eight WfLH studies (80%) and 15 BMIfA studies (65.2%).

Table 1 shows the number of comparisons by the size of difference between the local chart and international standard mean z-scores, according to each anthropometric index. A difference less than −0.5 SD or greater than +0.5 SD is considered important [100, 101]. Among the 43 studies on length/height-for-age, there were 130 comparisons done across different ages. Of these, 108 (83.1%) had mean z-score differences ranging from −0.5 SD to +0.5 SD. In 46 studies on weight-for-age, 53 (57.0%) out of 93 comparisons had mean z-score differences between −0.5 SD and +0.5 SD. All the 10 studies on weight-for-length/height had mean z-score differences from −0.5 SD to greater than 0.5 SD. Among the 23 studies on BMI-for-age and 19 studies on head circumference-for-age, 17 (50%) out of 34 comparisons and 28 (47.5%) out of 59 comparisons, respectively, had mean z-score differences of less than −0.5 SD. In studies where prevalences of SGA ($n = 11$), LGA ($n = 5$), wasting ($n = 4$), and underweight ($n = 8$) were reported, differences of less than 5% between the local and international charts occurred in 7 studies comparing SGA (63.6%), 3 studies

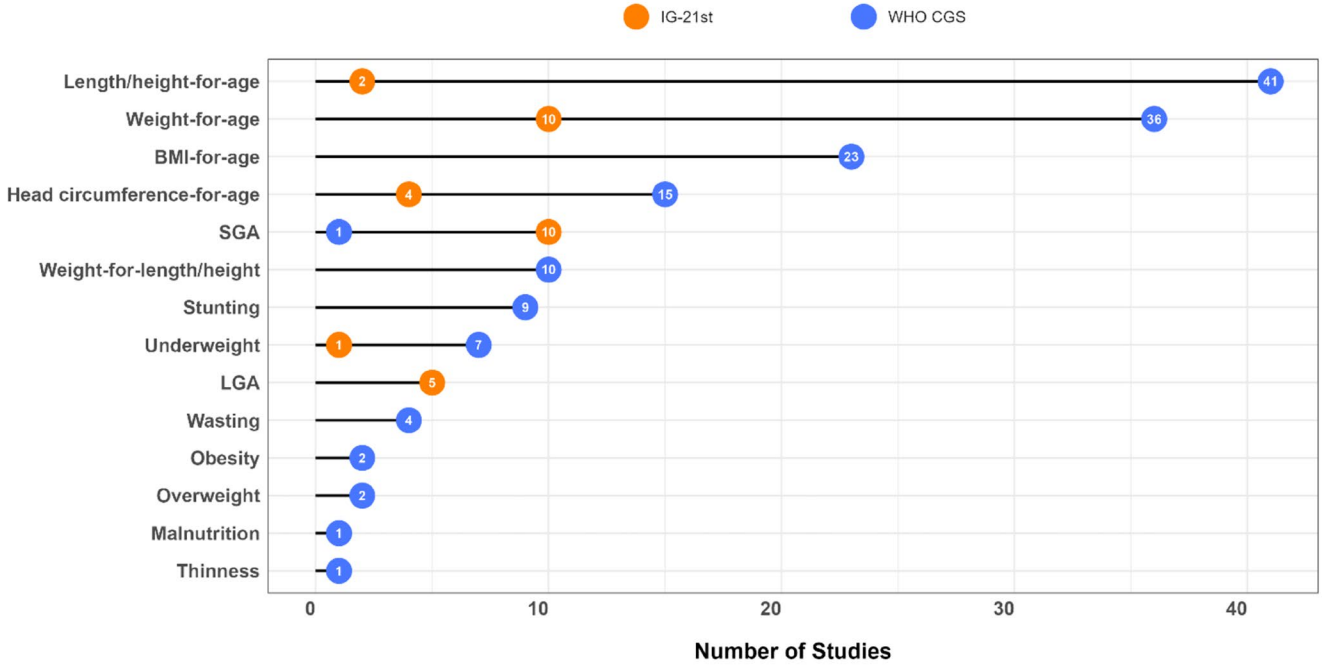

FIGURE 2 | Number of studies per anthropometric or nutritional indicator used in chart comparisons with each international standard.

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TABLE 1 | Mean z-score differences between local reference charts and international standards.

Mean z-score difference[a]	Number of comparisons				
	Length/ height-for-age (43 studies)	Weight-for-age (46 studies)	Weight-for-length/height (10 studies)	BMI-for-age (23 studies)	Head circumference-for-age (19 studies)
Difference less than −0.5 SD	11 (8.5%)	23 (24.7%)	0	17 (50%)	28 (47.5%)
Difference between −0.5 SD and +0.5 SD	108 (83.1%)	53 (57.0%)	29 (63.0%)	15 (44.1%)	22 (37.3%)
Difference greater than +0.5 SD	11 (8.5%)	17 (18.3%)	17 (37.0%)	2 (5.9%)	9 (15.3%)
Total	130	93	46	34	59

[a]Negative differences indicate that values of the local reference were lower than those of the international standard.

TABLE 2 | Classification rate differences between local reference charts and international standards.

Classification rate difference[a]	Number of comparisons						
	SGA (11 studies)	LGA (5 studies)	Stunting (9 studies)	Wasting (4 studies)	Underweight (8 studies)	Overweight (2 studies)	Obesity (2 studies)
Difference less than 5%	7 (63.6%)	3 (60%)	2 (22.2%)	3 (75%)	5 (62.5%)	1 (50%)	1 (50%)
Difference between 5% to 10%	3 (27.3%)	1 (20%)	4 (44.4%)	1 (25%)	2 (25%)	—	—
Difference greater than 10%	1 (9.1%)	1 (20%)	3 (33.3%)	—	1 (12.5%)	1 (50%)	1 (50%)
Total	11	5	9	4	8	2	2

[a]Percentage difference between the local reference and international standard in classification of children for each indicator.

for LGA (60%), 3 studies on wasting (75%), and 5 studies on underweight (62.5%) (Table 2).

Figure 3 displays the 95% confidence intervals around the percentage differences in prevalence of SGA, LGA, stunting, wasting, underweight, overweight, and obesity between local references and international standards. There were four (16%) out of 25 studies whose confidence intervals contained zero, suggesting the differences between the local charts and WHO CGS were not statistically significant (Figure 3A). Fifteen (71.4%) of the 21 studies whose confidence intervals did not touch zero favored WHO CGS, meaning the international standard classified more children as SGA, LGA, stunted, wasted, underweight, overweight, or obese than the local reference. Of the 16 studies that compared local charts with IG-21st, three (18.8%) had confidence intervals touching the line of no effect (Figure 3B). Out of the 13 studies with confidence intervals that did not include zero, six (46.2%) favored IG-21st, indicating the international standard produced higher prevalences of SGA, LGA, and underweight than local charts.

3.6 | Length/Height-For-Age z-Scores and Centiles

In 18 studies in Europe [46, 47, 50, 52, 61, 64–66], Asia [36, 37, 42, 86, 92, 93, 97], Africa [34, 44], and North America [73], z-scores derived from local reference charts were more often higher than those derived from WHO CGS. Other studies in Africa [41] and Latin America [74], as well as one multi-country study [25], found no differences between the local chart and either WHO CGS or IG-21st. In 18 studies with sex-specific charts, differences with WHO CGS were largest before 24 months (Figures S1B(A), C(A) and S2A(A,B)). One study in Europe [63] and another done in multiple Asian countries [28] reported the largest differences in LHfA percentiles between local and WHO CGS of 8 cm at 3 months and 4 cm at 24 months.

3.7 | Weight-For-Age z-Scores and Centiles

Weight-for-age values of local references were more often reported to be higher than values of WHO CGS (15 studies) and IG-21st (four studies) in Asia [36, 45–47, 81, 86, 89, 92, 93, 95, 97], Europe [50, 60, 61, 65–66], Africa [32, 44], and North America [73]. There were minimal differences in weight-for-age patterns between local charts and international standards in one study in Africa [41] (vs. WHO CGS) and another in Latin America (vs. IG-21st) [74]. Marked differences were observed at the 50th centile across 18 studies when compared to the WHO CGS across most ages, that is, reaching a maximum of 1.9 kg above and 2.3 kg below the WHO CGS chart (Figures S1B(B), C(B), and S2A(C,D)).

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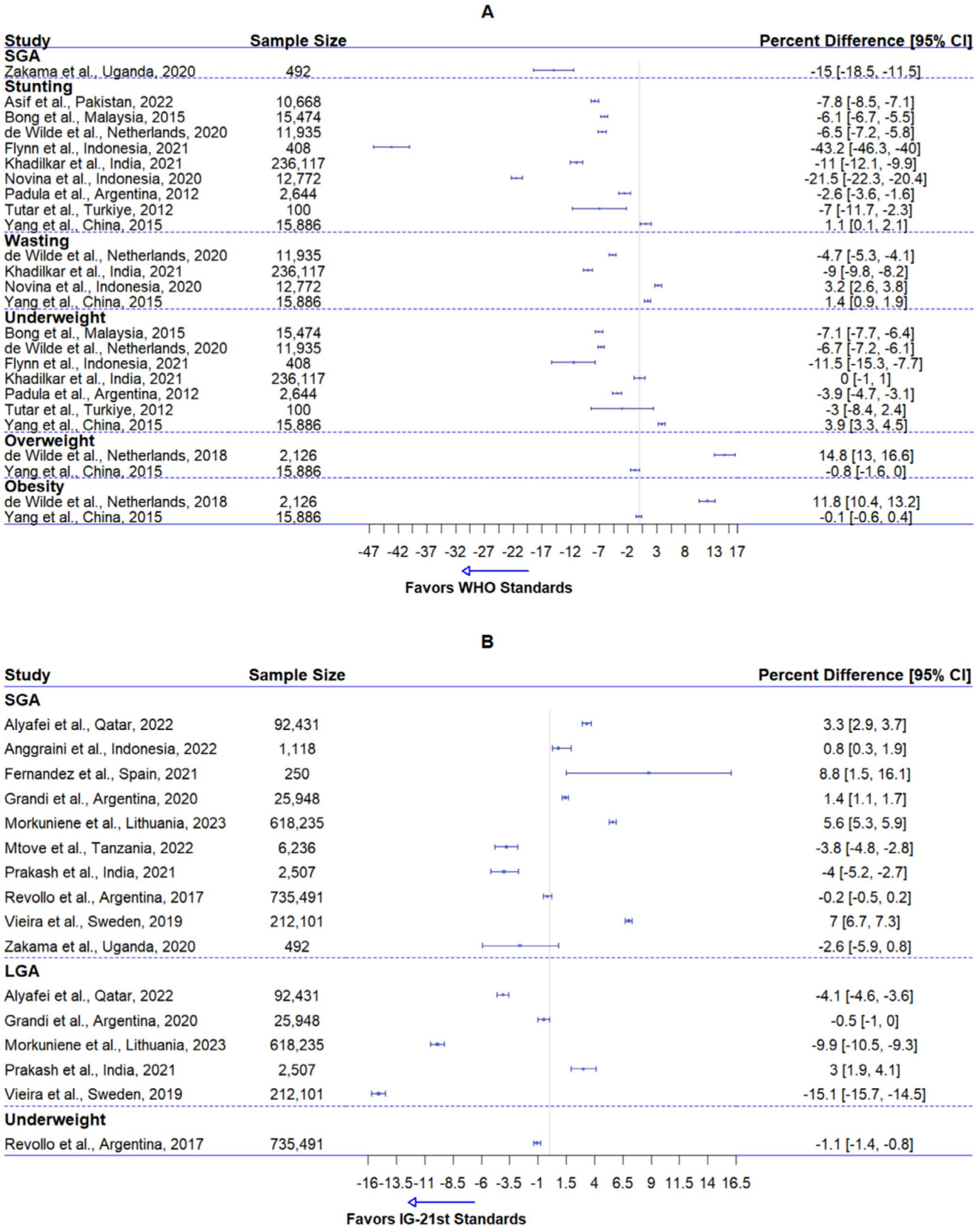

FIGURE 3 | Forest plots of percentage differences in prevalence of SGA, LGA, stunting, wasting, underweight, overweight, and obesity between local references and (A) WHO CGS and (B) IG-21st. Percent difference was calculated as local chart percent minus WHO or IG-21st standard.

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3.8 | Weight-For-Length/Height z-Scores and Centiles

Weight-for-length/height values of local references were more often reported to be lower than values of WHO CGS in seven studies in Asia [40, 86, 93–94], Europe [50, 52], and Africa [31] (Figures S1A(C) and S2C(A,B)).

3.9 | BMI-For-Age z-Scores and Centiles

BMI-for-age values of local references were more often reported to be lower than values of WHO CGS in eight studies in Asia [35, 37, 93], Europe [49, 64, 66], Africa [34], and North America [73]. Differences between the local reference and WHO CGS were small at most ages (Figure S1A(D)). In studies with sex-specific charts, there were larger differences with WHO CGS at all ages except at birth and 6 months (Figures S1B(C) and C(C)), and also at 60 months (Figure S2B(A,B)).

Two studies in Asia [35, 37], one in Africa [31], and one across multiple countries (Indonesia, Malaysia, Thailand, and Vietnam) [29] reported lower BMI values when using the local reference compared to the WHO CGS at 24 months and beyond (Figure S2B(A,B)).

3.10 | Head Circumference-For-Age z-Scores and Centiles

Head circumference-for-age values of local references were more frequently reported to be higher than values of WHO CGS (12 studies) and IG-21st (one study) in Europe [52–54, 57, 59, 64, 66], Asia [36, 47, 86, 93, 96], and Africa [30]. However, in two studies with combined charts and in one study with sex-specific charts, children appeared to have a larger head circumference-for-age when assessed using WHO CGS (Figures S1A(E), B(D), and C(D)). Using the local charts, children had larger 50th percentile head circumference values compared to WHO CGS, especially from 4 months of age (Figure S2B(C,D)).

3.11 | SGA and LGA Prevalences

Accurate estimation of gestational age (GA) is an important factor in the classification of SGA and LGA. An ultrasonographic measurement of fetal crown-rump length performed before 14 weeks of pregnancy is the gold standard for GA assessment [102]. Determination of GA was not reported in four (36.4%) out of 11 studies making SGA comparisons and in three (60%) of five studies making LGA comparisons. In the nine studies where pregnancy dating was reported, two (22.2%) used the last menstrual period (LMP), three (33.3%) used ultrasound, and four (44.4%) used LMP and ultrasound. The timing of GA assessment was not reported in eight (72.7%) out of 11 studies with SGA comparisons and in four (80%) of five studies with LGA comparisons. In the four studies where the timing of pregnancy dating was reported, two were in the first trimester and the other two were at 6–24 weeks. Out of 16 studies on SGA and LGA prevalence, 15 (93.8%) included women with singleton pregnancies, while one study did not report on plurality.

When compared with local reference charts, IG-21st was less likely to classify children as SGA (36.4% of SGA studies) but more likely to classify children as LGA (80% of LGA studies) (Table 2). Differences of less than 5% in classification rates between the local and international charts occurred in at least 60% of studies comparing SGA. There were higher reported rates of SGA using local references compared to IG-21st in seven out of 11 studies (Figure S3(A)). In Zakama et al. [33], the prevalence of SGA classification was almost double using WHO CGS compared with the local reference. In Morkuniene et al. [58] and Vieira et al. [67], the local references were twice as likely to classify children as SGA compared with IG-21st. IG-21st classified more children as LGA relative to the local charts in four out of five studies (Figure S3(B)). The largest differences in SGA were observed in two studies in Europe [62, 67] (8.8% and 7.0%) and one in Africa (15%) [33], while the biggest differences in classification of LGA were in two studies in Europe [58, 67] (15.1% and 9.9%) and one in Asia (4.1%) [43].

3.12 | Stunting, Wasting, and Underweight Prevalences

Differences greater than 5% in the classification of stunting were observed between the charts in seven (77.7%) out of nine studies, with the local chart reporting a lower percentage. WHO CGS classified more children as stunted relative to the local charts in eight out of nine studies (Figure S3(C)) [91]. Two out of four studies reported higher rates of wasting using local references compared to WHO CGS (Figure S3(D)). WHO CGS (five studies) and IG-21st (one study) classified more children as underweight relative to the local charts in six out of eight studies (Figure S3(E)). In Khadilkar et al. [76], there was no difference between the local chart and WHO CGS. The biggest differences in classification rates were in Asia [42, 76, 82–83] (7.8% to 43.2%) for stunting, whereas Asia [76, 83] (9% and 3.2%) and Europe [50] (4.7%) exhibited the largest differences for wasting. Differences in underweight were also most apparent in Asia [82, 97] (11.5% and 7.1%) and Europe (6.7%) [50]. De Wilde et al. [49] reported a lower rate of thinness using the local reference (2.9%) compared to WHO CGS (5.3%). Patel et al. reported a higher rate of malnutrition using the local reference (64.9%) compared to WHO CGS (29%) [77].

3.13 | Overweight and Obesity Prevalences

One study reported a higher rate of overweight and obesity using the local reference [49], while the other reported a lower rate [91], compared to WHO CGS (Figure S3(F),(G)).

4 | Discussion

A total of 76 studies representing 38 countries in various global regions were identified in this systematic review. About two-thirds of these studies featured comparisons in size or growth between local reference charts and WHO CGS. Most of these studies investigated differences in length/height-for-age and weight-for-age percentile or z-score values. The review found that children assessed using local charts had larger z-score

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or centile values in 18 out of 43 studies investigating length/height-for-age and in 19 out of 46 studies evaluating weight-for-age. Differences were age-specific and were most common in the first 24 months after birth—a crucial period of rapid child growth (first 1000 days) that requires close monitoring. Centile and z-score values also differed by gender in some instances, where opposite trends would be observed for males and females at different ages.

4.1 | Overall Differences Between Local Reference Charts and International Child Growth Standards

Some of the differences observed between local reference charts and international child growth standards were large and may underscore important clinical significance. Across anthropometric indices, WHO charts were more often reported to have higher weight-for-length/height and BMI-for-age z-score or centile values than local charts.

In nutritional indices, differences between local and WHO charts were largest for stunting, while differences between local and IG-21st charts were largest for LGA. In Scherdel et al., the prevalence of stunting was generally found to be higher with WHO CGS than other charts, showing concordance with our findings. However, the review by Scherdel et al. found that the prevalence of underweight was generally lower when using WHO CGS compared to other charts, contradicting our findings.

We have found that nearly all the studies comparing differences between national references and international standards showed poor agreement between the two charts. The main reasons given for the divergence between national and international charts include differences in centile construction methodologies, sampling criteria, measurement instruments or techniques [103]. These factors contribute to observed heterogeneity within and across different local and global populations. Other differences are a result of not using an appropriate chart for a specific population. For example, using WHO CGS in preterm babies even though it was constructed exclusively for term babies would lead to inaccurate rates of attained size by gestational age [92].

Studies that showed agreement between local and international charts attempted to apply similar sampling criteria and chart construction methodology as were used when constructing international growth standards [25, 41, 74]. These studies support the potential for wide-ranging applicability of growth standards across multiple countries and regions.

4.2 | Strengths and Limitations

The strengths of this review are that it has systematically and comprehensively gathered existing published evidence for differences observed when applying local charts versus international standards across multiple anthropometric and nutritional indicators of under-five child growth. It also extends and updates the study done by Scherdel et al. [19] by including comparisons with two international standards and studies published beyond 2006 and up to December 2023. The present review provides a useful reference for researchers, health practitioners, and policy makers to update their current knowledge and offer insights to guide their practice and decision-making on child growth monitoring.

However, a few limitations exist. The review focused only on published research articles found in electronic databases and might have missed out on important information available in non-published sources such as reports and case files. We also only included articles in English, and only one reviewer conducted all the data extraction due to constraints of time and funding. Our review did not perform a risk of bias assessment for included studies. Although this is usually expected for systematic reviews, our focus was not on the methodological rigor of included studies, but on the reported differences in growth measures between national and international charts. Another potential limitation is that a protocol was not prepared for this study. However, we acknowledge the importance of registering a systematic review protocol to promote transparency and avoid duplication with other studies. Despite the aforementioned limitations, we applied rigor to the systematic review process to minimize biases and ensure accurate reporting of results in accordance with relevant guidelines.

4.3 | Implications for Future Research and Use of Growth Standards

Much variation exists in child growth monitoring practices around the world. While growth standards have demonstrated their applicability across multiple geographies and ethnicities, there remains a lack of consensus as to their adoption globally. This is evident in countries where locally developed charts are still in use and preferred over international charts such as WHO CGS and IG-21st charts.

The systematic review has highlighted major differences and implications in using different charts to assess the size and growth of children below 5 years of age. Inappropriate application of growth charts can precipitate detrimental clinical and public health consequences, where children who need closer monitoring are missed while those on the right growth trajectory for their age are misclassified. The two international standards (WHO and INTERGROWTH-21st) account for important factors influencing growth, have been constructed using robust methodology, and therefore provide a universal standard against which to monitor growth at the individual and population levels. International growth standards tend to be consistent across multiple ethnicities and geographies for children under the age of five [25].

As of December 2023, over 160 countries have adopted the WHO charts (Dr. Muriel of WHO, personal communication). Adopting a common growth standard globally is essential for tracking progress towards global nutrition targets [104]. However, guidance is currently lacking to provide clarity on how and when the two existing complementary standards should be applied. In light of this, a project titled "Guidance for International Growth Standards" (GIGS) was launched in 2022 with the aim of providing guidance for researchers and policymakers on the proper use of growth standards for the assessment of preterm and term born children alike under the age of 5 years. The GIGS project will produce and disseminate global goods consisting of a suite of statistical tools [105, 106], and several papers focused on

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aspects of growth that aim to provide guidance on how to appropriately use the international standards, for whom, and when. The GIGS project aims to facilitate and promote standardised growth monitoring of children from birth to 5 years with the appropriate international growth standards.

5 | Conclusion

While reference charts describe growth in a specific population, growth standards prescribe how growth should occur when the right conditions are in place. The use of an international standard is recommended for ensuring accurate growth monitoring of children under 5 years, regardless of their location of birth. This review has uncovered the far-reaching implications of using multiple references or standards in different settings. These include under- or over-diagnosis of children's nutritional status, inaccurate estimates of population-level child growth indicators, and suboptimal resource allocation to growth monitoring and promotion programs. Guidance on when and how to use growth standards is needed to encourage wider adoption and facilitate comparisons across multiple local and global populations.

Author Contributions

E.O.O. and L.V. conceived the study idea. B.N. performed the literature search and data extraction. B.N., E.O.O., and L.V. contributed to the analysis. B.N. drafted the manuscript. E.O.O. supervised all stages of project development and completion and is the guarantor of the work. All authors read, reviewed, and approved the final version of the manuscript.

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Ethics Statement

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors have nothing to report.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Appendix S1:** Search strategies. **Figure S1:** Plots of mean z-score differences for anthropometric indices. A: Mean z-score differences in studies without sex-specific local charts for (A) length/height-for-age, (B) weight-for-age, (C) weight-for-length/height, (D) BMI-for-age, and (E) head circumference-for-age. B: Mean z-score differences for males in studies with sex-specific local charts for (A) length/height-for-age, (B) weight-for-age, (C) BMI-for-age, and (D) head circumference-for-age. C: Mean z-score differences for females in studies with sex-specific local charts for (A) length/height-for-age, (B) weight-for-age, (C) BMI-for-age, and (D) head circumference-for-age. **Figure S2:** Plots of 50th percentile differences for anthropometric indices. A: 50th percentile differences (local chart minus WHO CGS) in length/height-for-age and weight-for-age among males (A and C, respectively) and females (B and D, respectively). B: 50th percentile differences (local chart minus WHO CGS) in BMI-for-age and head circumference-for-age among males (A and C, respectively) and females (B and D, respectively). C: 50th percentile differences (local chart minus WHO CGS) in weight-for-length/height among (A) males and (B) females. D: 50th percentile differences (local chart minus IG-21st) in birth weight-for-age and birth head circumference-for-age among males (A and C, respectively) and females (B and D, respectively). **Figure S3:** Plots of prevalence rates for nutritional indicators. Prevalence of (A) SGA, (B) LGA, (C) stunting, (D) wasting, (E) underweight, (F) overweight, and (G) obesity using local references compared to WHO CGS and IG-21st. **Table S1:** Summary of study characteristics. **Table S2:** Types of charts compared by region, country, and age ranges. **Table S3:** Effect direction table for local reference compared to international standard z-score or centile values. **Data S1:** Technical Advisory Group (TAG) members and affiliations.

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