Prevalence estimates of sickle cell disease among children and adolescents in sub-Saharan Africa: a systematic review and modelling analysis

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Summary

Background There is a scarcity of data reporting on the burden of sickle cell disease across many African settings, particularly among children, who have the highest risk of preventable morbidity and mortality in the absence of early diagnosis and care. We aimed to estimate the prevalence of sickle cell disease and the absolute number of paediatric cases in sub-Saharan Africa to inform policy and service responses.

Methods For this systematic review and modelling analysis, we searched MEDLINE, Embase, Global Health (CABI), and African Journals Online (AJOL) for studies published from Jan 1, 2000, to Sept 10, 2025, that reported the prevalence of sickle cell disease among children and adolescents younger than 15 years in sub-Saharan Africa. We pooled crude prevalence using random-effects meta-analysis. We then fitted a mixed-effects meta-regression for age band (infants [aged 0 to <12 months], children aged <5 years, children and adolescents aged <15 years), sickle cell disease phenotype (total sickle cell diseases, haemoglobin SS [HbSS], haemoglobin SC [HbSC], and other compound heterozygous variants), Socio-demographic Index (SDI), World Bank income group, and geographical coordinates (latitude, longitude, interaction), plus a country random intercept. Absolute cases for 2023 were derived with the UN World Population Prospects.

Findings 40 studies contributed 71 prevalence datapoints from 22 countries across all four subregions of sub-Saharan Africa. Estimated prevalence for all sickle cell diseases was 1·54% (95% CI 0·34–7·49) in infants, 1·51% (0·35–6·72) in children younger than 5 years, and 1·78% (0·21–12·09) in children and adolescents younger than 15 years. By haemoglobin phenotype, the prevalence of HbSS was 0·70% (0·15–3·44) in infants, 0·69% (0·17–2·80) in children younger than 5 years, and 0·80% (0·09–5·11) in children and adolescents younger than 15 years, while that of HbSC was 0·29% (0·06–1·46), 0·28% (0·05–1·50), and 0·33% (0·04–2·43) across the same age groups, respectively. Using UN 2023 population denominators, we estimated 1 165 800 (95% CI 260 600–5 662 100) cases in infants, 2 752 200 (632 700–12 253 200) cases in children younger than 5 years, and 8 854 800 (1 068 900–60 148 700) cases in children and adolescents younger than 15 years living with sickle cell disease in sub-Saharan Africa in 2023. Regional prevalence (children aged <5 years, all sickle cell diseases) was highest in central Africa (2·07% [95% CI 0·30–12·76]), followed by west, southern, and east Africa. The burden was concentrated in populous countries, particularly Nigeria, Ethiopia, and the Democratic Republic of the Congo. Study quality was moderate overall and heterogeneity was substantial.

Interpretation Despite data gaps in many countries, the burden of sickle cell disease, especially in west and central Africa, underscores the urgent need to scale up newborn and early childhood screening, prophylaxis, vaccination, and comprehensive care within child health platforms, alongside strengthened surveillance to close evidence gaps and guide sustainable policy reforms.

Funding None.

Lancet Child Adolesc Health 2026

Published Online
April 20, 2026
https://doi.org/10.1016/S2352-4642(26)00048-9

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Introduction

Sickle cell disease is among the leading inherited disorders globally.[1] The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) showed that the number of babies born with sickle cell disease increased from 453 000 in 2000 to 515 000 in 2021, while prevalent cases rose from 5·5 million to 7·7 million over the same period.[2] Sub-Saharan Africa bears the greatest burden, with an estimated 66% of the world's 120 million people with sickle cell disease living in the region, and about 1000 affected infants born each day.[3]

Sickle cell disease is an autosomal recessive disorder, most commonly presenting as sickle cell anaemia (haemoglobin SS [HbSS]), with haemoglobin SC (HbSC), HbS beta-thalassemia (β-Thal) and other compound heterozygotes also contributing to the burden.[3] In malaria-endemic regions such as sub-Saharan Africa, the prevalence of the sickle cell trait (HbAS) ranges from

Research in context

Evidence before this study

We searched PubMed, Embase, Global Health (CABI), and Africa Journals Online for studies published between Jan 1, 2000, and Sept 10, 2025, reporting the prevalence or burden of sickle cell disease among children in sub-Saharan Africa. Global modelling analyses from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021 estimated 2·3 million sickle cell disease cases in children younger than 5 years in 2023 and 4·2 million in those younger than 15 years, with substantially lower estimates for infants. Earlier modelling by Piel and colleagues (2013) projected high birth prevalence in west and central Africa, and a 2018 meta-analysis by Wastnedge and colleagues reported a birth prevalence in Africa of 1·13%. Many existing analyses focused on modelling births and survival or pooling heterogeneous datasets, with minimal generation of country-specific, age-stratified, and phenotype-specific estimates based directly on observed paediatric prevalence data. Moreover, available data from individual studies are geographically uneven and frequently derived from selected urban or hospital-based populations.

Added value of this study

This study expands on existing evidence by providing country-level estimates of paediatric sickle cell disease prevalence and burden across sub-Saharan Africa, addressing a major gap between global modelling outputs and national service needs. By synthesising available population-based data and stratifying estimates by age group and haemoglobin phenotype, our findings improve the understanding of how the sickle cell disease burden is distributed across children in sub-Saharan Africa. This study explores discrepancies between previous global estimates and observed prevalence patterns, and highlights where evidence is strongest or weakest, to support more targeted policy and research prioritisation.

Implications of all the available evidence

Taken together with existing global and regional evidence, our findings not only reinforce that sickle cell disease represents a substantial and largely preventable paediatric burden in sub-Saharan Africa but also demonstrate that the burden is highly concentrated in specific countries and age groups. These findings support prioritisation of country-led newborn and early-childhood screening strategies, integration of sickle cell disease care into primary child-health platforms, and differentiated approaches for high-burden and low-burden settings. The findings also underscore the need for investment in population-representative surveillance and longitudinal cohorts to improve estimates, monitor survival, and evaluate the impact of interventions, particularly beyond infancy and into adolescence.

10% to 40%, conferring protection against malaria but sustaining high rates of sickle cell disease inheritance.[3,4]

Across much of sub-Saharan Africa, however, newborn screening for sickle cell disease is rare, with most diagnoses occurring after severe crises, and access to comprehensive sickle cell disease care remains scarce.[5] Mortality in children with sickle cell disease remains unacceptably high in many countries in sub-Saharan Africa. Although precise estimates are limited by the scarcity of population-based survival data, various modelling exercises and simulations have suggested substantial excess mortality in early childhood,[6] often indicating that a large proportion of affected infants do not reach the age of 5 years in the absence of early diagnosis and treatment.[6,7]

See Online for appendix

Although WHO and the UN have designated sickle cell disease as a global public health problem,[3] the implementation of effective prevention and care strategies in sub-Saharan Africa continues to lag behind what is obtainable in many high-income settings.[7] Moreover, a more comprehensive understanding of the burden is needed to ensure an improved and targeted response in many African countries.[8,9] Accurate data on the prevalence, epidemiology, and distribution of sickle cell disease are required to strengthen awareness among health professionals, policy makers, and communities.[7] In this study, we aimed to synthesise the available evidence to estimate the regional and country-level prevalence and absolute numbers of sickle cell disease cases in children across sub-Saharan Africa to guide health-system planning and interventions.

Methods

Search strategy and selection criteria

We adhered to the PRISMA and GATHER guidelines in the conduct of this study.[10,11] We did not seek any ethics approval for this study, since all data were from publicly available studies.

We searched MEDLINE, Embase, Global Health (CABI), and Africa Journals Online (AJOL) for studies on the epidemiology of sickle cell disease in sub-Saharan Africa. Search terms are shown in the appendix (pp 1–2). Searches were conducted on Sept 10, 2025, and restricted to studies published on or after Jan 1, 2000. Unpublished documents were sourced from Google Scholar and Google searches. Titles and abstracts of studies were reviewed and full texts of relevant studies accessed. The reference lists of accessed full texts were further hand-searched for additional studies. There were no language restrictions.

We primarily selected population-based studies reporting on the prevalence or epidemiology of sickle cell disease among children younger than 15 years in any setting in sub-Saharan Africa. However, due to the high number of hospital-based reports providing estimates of the burden of sickle cell disease identified from our previous study,[7]

we also carefully reviewed hospital-based studies and selected such studies when there was an appropriate description of the reference population denominator of the hospital. We excluded studies that focused only on the adult population; studies that were conducted exclusively among special population groups, including highly selected clinical cohorts such as children admitted to hospital with severe anaemia, transfusion-dependent patients, children attending specialist haematology clinics, refugee or displaced populations, or HIV programme enrollees; studies that did not report on epidemiology or prevalence rates; studies with the designs or case identification not clearly defined or consistently applied; and studies that were reviews, opinion papers, viewpoints, or commentaries. The phenotypes of sickle cell disease included in our study were: HbSS (homozygote) and HbSC (heterozygote). We broadly grouped other heterozygotes, including HbS β-Thal, haemoglobin SD (HbSD), haemoglobin SE (HbSE), and haemoglobin SO (HbSO), when identified, as "others".[3]

Study selection and quality assessment were conducted independently by two reviewers (DA and AA). An eligibility guideline was applied to ensure consistency and any disagreement in study selection was resolved by consensus. Data on the location, study period, study design, study setting (urban, rural, or mixed), diagnostic criteria, and mean child age were extracted. These were matched with corresponding data on sickle cell disease cases, sample population, and prevalence of sickle cell disease type in each study. For studies conducted on the same study site, population, or cohort, the first published study was selected, and all additional data from the other studies were extracted and merged with data from the selected paper. The methodological quality of each full-text article was assessed with an adapted five-domain quality appraisal tool (based on the STROBE statement).[12] Although STROBE is not a formal risk-of-bias tool, we used it pragmatically, as in previous studies,[13,14] to guide a transparent and consistent assessment of key sources of bias relevant to prevalence studies, rather than completeness of reporting. Specifically, we evaluated: selection (representativeness of the sampled population); sample size adequacy; participation or response rate; outcome ascertainment (case definition and measurement); and analytical methods (appropriateness of statistical approach and control for bias). Each domain was scored as 0 (high risk of bias), 1 (moderate risk), or 2 (low risk according to explicit criteria; appendix p 3). Domain scores were summed to give a total score ranging from 0 to 10. Studies were categorised as high (8–10), moderate (5–7), and low (0–4) quality. Quality scores were not used to weight model estimation but were examined as potential moderators in exploratory subgroup analyses.

Data analysis

We combined study-level estimates of sickle cell disease prevalence with country-level covariates and population denominators to generate pooled and country-specific estimates across sub-Saharan Africa. Country-level covariates included the Socio-demographic Index (SDI; a composite measure of income, education, and fertility), World Bank income group, and geographical location (latitude and longitude). UN World Population Prospects 2023 estimates were used as population denominators, reflecting the most recent investigation period covered by included studies. This approach has been applied in our previous population health estimates.[13,14]

Analyses were conducted for three predefined paediatric age bands: infants (0 to <12 months), children younger than 5 years (0 to <5 years), and children and adolescents younger than 15 years (0 to <15 years). For each age group, we first estimated pooled prevalence using random-effects meta-analysis, accounting for within-study and between-study variability. Statistical heterogeneity was assessed with the I^2 statistic, and subgroup analyses by age group, haemoglobin phenotype, and subregion were done to explore sources of heterogeneity.

To generate country-level estimates, we fitted a mixed-effects meta-regression model that related observed prevalence to age group, haemoglobin phenotype, SDI, World Bank income group, and geographical location, while accounting for residual between-country heterogeneity through a country-level random intercept. For study (or observation) i in country c and (if present) repeated row j (for multiple estimates from a study), the model equation for prevalence on a logit scale is given as:

$$\begin{aligned} logit(p_{ij}) = {} & \beta_0 + \beta_1 SDI_{ij} + \beta_2 (SDI_{ij})^2 + \beta_3 IncomeEnc_{ij} \\ & + \alpha \Sigma \beta_{age,a} I(Age_{ij}=a) + s \Sigma \beta_{subtype,s} I(Subtype_{ij}=s) \\ & + \beta_4 lon_{ij} + \beta_5 lat_{ij} + \beta_6 lon_{ij} \times lat_{ij} + u_{c[i]}. \end{aligned}$$

where I denotes indicator (dummy) variables (reference age=infants; reference subtype=total); the $(SDI_{ij})^2$ term indicates a non-linear relationship in the effect of deprivation; lon_{ij} and lat_{ij} are the study country longitude and latitude (degrees) for observation ij; $u_c \sim N(0,\sigma^2 u)$ is the country random intercept assumed to follow a normal distribution with mean zero and variance $(0,\sigma^2 u)$ capturing residual between-country heterogeneity not explained by the fixed effects. This approach allowed estimation for countries without eligible prevalence data by leveraging shared socioeconomic and spatial characteristics.

Absolute numbers of children living with sickle cell disease were estimated by applying modelled prevalence to corresponding UN 2023 population denominators for each country and age group. Regional case counts and those for sub-Saharan Africa as a whole were obtained by summing country-level estimates, and regional prevalence was calculated by dividing total estimated cases by the total regional population for the same age band. All analyses were done with R (version 4.3) and Python (version 3.11). Full statistical details, additional

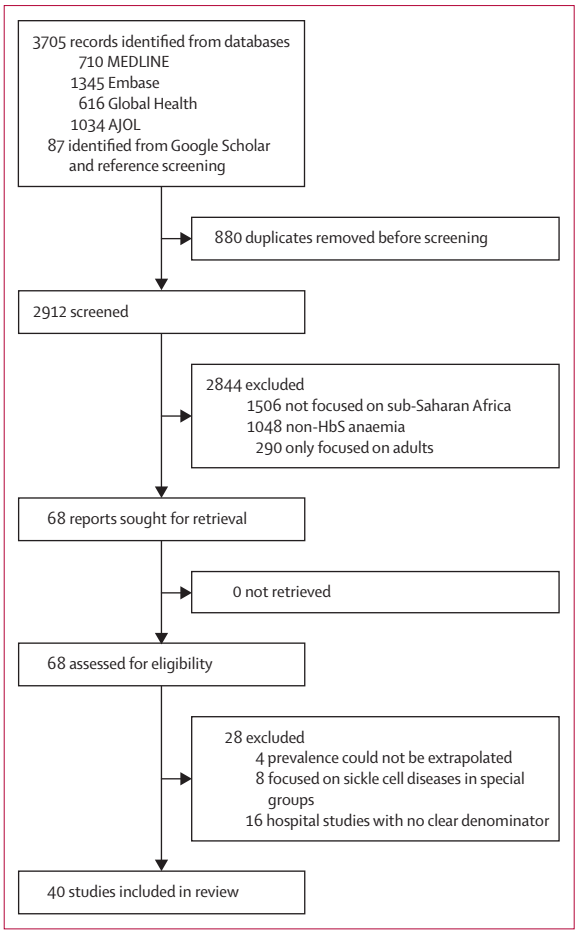

Figure 1: **Study selection**
HbS=haemoglobin S.

equations, and model diagnostics are provided in the appendix (pp 4–8).

Role of the funding source

There was no funding source for this study.

Results

The database searches returned 3705 records, with 87 additional records identified through Google Scholar and reference screening. After removal of duplicated records, 2912 titles and abstracts were screened for relevance, with 2844 excluded. We assessed 68 full texts for eligibility, with 40 studies (appendix pp 9–16) covering 71 prevalence datapoints and all four regions in sub-Saharan Africa and 22 countries included for analysis (figure 1). Among datapoints with assignable subregions (n=63), more than half were from west Africa (n=33, 52%), followed by east Africa (n=16, 25%), central Africa (n=12, 19%), and southern Africa (n=2, 3%), with six studies spanning multiple subregions. Of the 40 studies, 20 were conducted in mixed or semi-urban settings, 15 in urban settings, and five in rural settings, and together they included more than 1·55 million participants between 2002 and 2023. Most datapoints related to paediatric screening and were predominantly in children younger than 5 years. Overall study quality was moderate (mean score 6·2), with few high-quality studies (appendix pp 17–18).

The pooled prevalence of all sickle cell diseases in sub-Saharan Africa was 1·54% (95% CI 0·34–7·49) in infants, 1·51% (0·35–6·72) in children younger than 5 years, and 1·78% (0·21–12·09) in those younger than 15 years (table). By haemoglobin phenotype, the prevalence of HbSS was 0·70% (95% CI 0·15–3·44) in infants, 0·69% (0·17–2·80) in children younger than 5 years, and 0·80% (0·09–5·11) in children and adolescents younger than 15 years, while the prevalence of HbSC was 0·29% (0·06–1·46), 0·28% (0·05–1·50), and 0·33% (0·04–2·43) across the same age groups, respectively. Across sub-Saharan Africa, overall prevalence of sickle cell disease among children younger than 5 years was highest in central Africa at 2·07% (95% CI 0·30–12·76), followed by west Africa at 1·74% (0·46–6·99), southern Africa at 1·31% (0·29–5·94), and east Africa at 1·04% (0·27–4·64). Similar patterns were observed for infants and for children younger than 15 years. In infants, sickle cell disease prevalence ranged from 2·12% (95% CI 0·29–15·34) in central Africa and 1·78% (0·46–7·54) in west Africa to 1·34% (0·26–6·94) in southern Africa, and 1·06% (0·27–4·85) in east Africa. Among those younger than 15 years, estimates were 2·51% (95% CI 0·20–17·42) in central Africa, 2·03% (0·27–13·59) in west Africa, 1·54% (0·23–9·51) in southern Africa, and 1·24% (0·17–8·94) in east Africa (table).

Using UN 2023 population projections, we estimated 1 165 800 (95% CI 260 600–5 662 100) sickle cell disease cases in infants, 2 752 200 (632 700–12 253 200) cases in children younger than 5 years, and 8 854 800 (1 068 900–60 148 700) cases in those younger than 15 years across sub-Saharan Africa. At the phenotype level in children younger than 5 years, this comprised approximately 1 250 500 (303 800–5 100 500) HbSS cases and 515 800 (95 400–2 745 200) HbSC cases, with the remaining 985 900 (233 500–4 407 600) cases attributable to other phenotypes. Subregional burdens broadly mirrored prevalence patterns. For children younger than 5 years (all sickle cell diseases), estimated cases were highest in west Africa (1 150 700; 95% CI 306 000–4 623 300), followed by east Africa (767 500; 197 200–3 407 400), central Africa (742 100; 109 300–4 579 400), and southern Africa (91 800; 20 200–415 500). Among children younger than 15 years, the corresponding estimates were 3 752 700 (505 400–25 144 500) in west Africa, 2 476 300 (334 800–17 866 200) in east Africa, 2 324 200 (183 100–16 156 700) in central Africa, and 301 600 (45 600–1 866 000) in southern Africa. By phenotype and region, the HbSS burden in children younger than 5 years was 488 800 (143 000–1 877 400) in west Africa, 398 300 (51 100–1 804 200) in central Africa, 324 500 (101 700–1 225 700) in east Africa, and 38 900 (8000–192 200)

	Prevalence (95% CI)			Cases, thousands (95% CI)		
	Infants (aged 0 to <12 months)	Children aged <5 years	Children and adolescents aged <15 years	Infants (aged 0 to <12 months)	Children aged <5 years	Children and adolescents aged <15 years
Central Africa						
HbSS	1·13% (0·13–6·75)	1·11% (0·14–5·03)	1·29% (0·08–6·61)	170·6 (19·0–1015·8)	398·3 (51·1–1804·2)	1199·5 (77·8–6134·3)
HbSC	0·47% (0·05–2·64)	0·46% (0·05–2·87)	0·53% (0·03–4·41)	70·5 (7·4–397·5)	164·6 (16·8–1028·3)	495·5 (32·1–4088·3)
Others	1·07% (0·12–5·95)	1·04% (0·12–4·87)	1·21% (0·08–6·35)	160·4 (18·0–894·9)	371·8 (41·3–1746·9)	1123·4 (73·2–5895·1)
Total	2·12% (0·29–15·34)	2·07% (0·30–12·76)	2·51% (0·20–17·42)	318·9 (44·3–2308·2)	742·1 (109·3–4579·4)	2324·2 (183·1–16 156·7)
East Africa						
HbSS	0·45% (0·13–1·89)	0·44% (0·14–1·67)	0·52% (0·07–3·78)	136·6 (38·7–574·9)	324·5 (101·7–1225·7)	1047·0 (141·6–7550·4)
HbSC	0·19% (0·05–0·85)	0·18% (0·04–0·89)	0·22% (0·03–1·55)	56·2 (13·9–259·0)	133·6 (30·2–653·0)	431·0 (58·3–3107·6)
Others	0·43% (0·10–2·10)	0·42% (0·09–2·08)	0·50% (0·07–3·60)	130·2 (30·0–636·5)	309·5 (65·3–1528·6)	998·3 (134·9–7208·2)
Total	1·06% (0·27–4·85)	1·04% (0·27–4·64)	1·24% (0·17–8·94)	323·1 (82·5–1470·3)	767·5 (197·2–3407·4)	2476·3 (334·8–17 866·2)
Southern Africa						
HbSS	0·57% (0·10–3·41)	0·56% (0·11–2·75)	0·65% (0·10–4·02)	15·9 (2·7–95·6)	38·9 (8·0–192·2)	127·6 (19·3–789·5)
HbSC	0·23% (0·05–1·19)	0·23% (0·05–1·10)	0·27% (0·04–1·66)	6·5 (1·3–33·5)	16·0 (3·4–76·7)	52·6 (8·0–325·1)
Others	0·54% (0·11–2·34)	0·53% (0·13–2·09)	0·62% (0·09–3·83)	15·1 (3·2–65·6)	37·0 (8·9–146·6)	121·4 (18·4–751·4)
Total	1·34% (0·26–6·94)	1·31% (0·29–5·94)	1·54% (0·23–9·51)	37·6 (7·2–194·7)	91·8 (20·2–415·5)	301·6 (45·6–1866·0)
West Africa						
HbSS	0·76% (0·20–3·34)	0·74% (0·22–2·84)	0·86% (0·12–5·93)	206·6 (53·7–913·4)	488·8 (143·0–1877·4)	1594·0 (214·5–10 960·9)
HbSC	0·31% (0·07–1·50)	0·30% (0·07–1·49)	0·36% (0·05–2·44)	85·2 (20·4–410·2)	201·6 (45·0–987·7)	657·5 (88·4–4522·5)
Others	0·71% (0·19–2·70)	0·70% (0·18–2·66)	0·81% (0·11–5·22)	194·4 (52·3–739·4)	460·2 (118·0–1758·2)	1501·2 (202·5–9661·0)
Total	1·78% (0·46–7·54)	1·74% (0·46–6·99)	2·03% (0·27–13·59)	486·3 (126·5–2063·0)	1150·7 (306·0–4623·3)	3752·7 (505·4–25 144·5)
Sub-Saharan Africa (overall)						
HbSS	0·70% (0·15–3·44)	0·69% (0·17–2·80)	0·80% (0·09–5·11)	529·8 (114·2–2600·0)	1250·5 (303·8–5100·5)	3968·1 (453·1–25 435·6)
HbSC	0·29% (0·06–1·46)	0·28% (0·05–1·50)	0·33% (0·04–2·43)	218·5 (42·9–1100·2)	515·8 (95·4–2745·2)	1636·6 (186·7–12 084·5)
Others	0·55% (0·14–2·60)	0·54% (0·13–2·42)	0·65% (0·09–4·55)	417·5 (103·4–1961·9)	985·9 (233·5–4407·6)	3250·1 (429·0–22 628·6)
Total	1·54% (0·34–7·49)	1·51% (0·35–6·72)	1·78% (0·21–12·09)	1165·8 (260·6–5662·1)	2752·2 (632·7–12 253·2)	8854·8 (1068·9–60 148·7)

Other sickle cell disease phenotypes include haemoglobin S beta-thalassemia (HbS β-Thal), haemoglobin SD (HbSD), haemoglobin SE (HbSE), and haemoglobin SO (HbSO). HbSS=haemoglobin SS. HbSC=haemoglobin SC.

Table: **Regional distribution of sickle cell disease prevalence and cases among children and adolescents in sub-Saharan Africa**

in southern Africa; while the prevalence of HbSC cases was 201 600 (45 000–987 700) in west Africa, 164 600 (16 800–1 028 300) in central Africa, 133 600 (30 200–653 000) in east Africa, and 16 000 (3400–76 700) in southern Africa. Among children younger than 15 years, HbSS cases numbered 1 594 000 (214 500–10 960 900) in west Africa, 1 199 500 (77 800–6 134 300) in central Africa, 1 047 000 (141 600–7 550 400) in east Africa, and 127 600 (19 300–789 500) in southern Africa; HbSC cases were 657 500 (88 400–4 522 500) in west Africa, 495 500 (32 100–4 088 300) in central Africa, 431 000 (58 300–3 107 600) in east Africa, and 52 600 (8000–325 100) in southern Africa (table, figure 2).

Marked heterogeneity was observed across countries (appendix pp 19–23). In west Africa, Nigeria reported approximately 196 000 cases in infants, 464 000 cases in children younger than 5 years, and more than 1 500 000 cases in those younger than 15 years, with a pooled prevalence of 1·6% in children and adolescents younger than 15 years. Niger (117 200 cases in children <5 years; 361 500 cases in children <15 years) and Côte d'Ivoire (116 100 cases in children <5 years; 380 800 cases in children <15 years) also contributed substantially. In east Africa, Ethiopia carried the largest burden, with 98 100 cases in infants, 233 300 in children younger than 5 years, and 727 800 in those younger than 15 years, with a prevalence of 1·4% in those younger than 15 years. Kenya (101 000 cases in children <5 years; 349 200 cases in children and adolescents aged <15 years) and Mozambique (81 900 cases in children <5 years; 255 200 cases in children and adolescents aged <15 years) followed. In central Africa, the Democratic Republic of the Congo had the largest national burden, with 180 300 infant cases, 416 400 cases in children younger than 5 years, and more than 1 300 000 cases in those younger than 15 years, with a prevalence of 2·7% in those younger than 15 years. Angola contributed 110 000 cases in children younger than 5 years and 340 000 in those younger than 15 years, while Cameroon had 70 200 cases in children younger than 5 years and 222 000 in those younger than 15 years. In southern Africa, South Africa contributed 30 300 infant cases, 74 000 cases in children younger than 5 years, and 243 200 in those younger than 15 years, with prevalence of 1·5% in those younger than 15 years. Namibia and

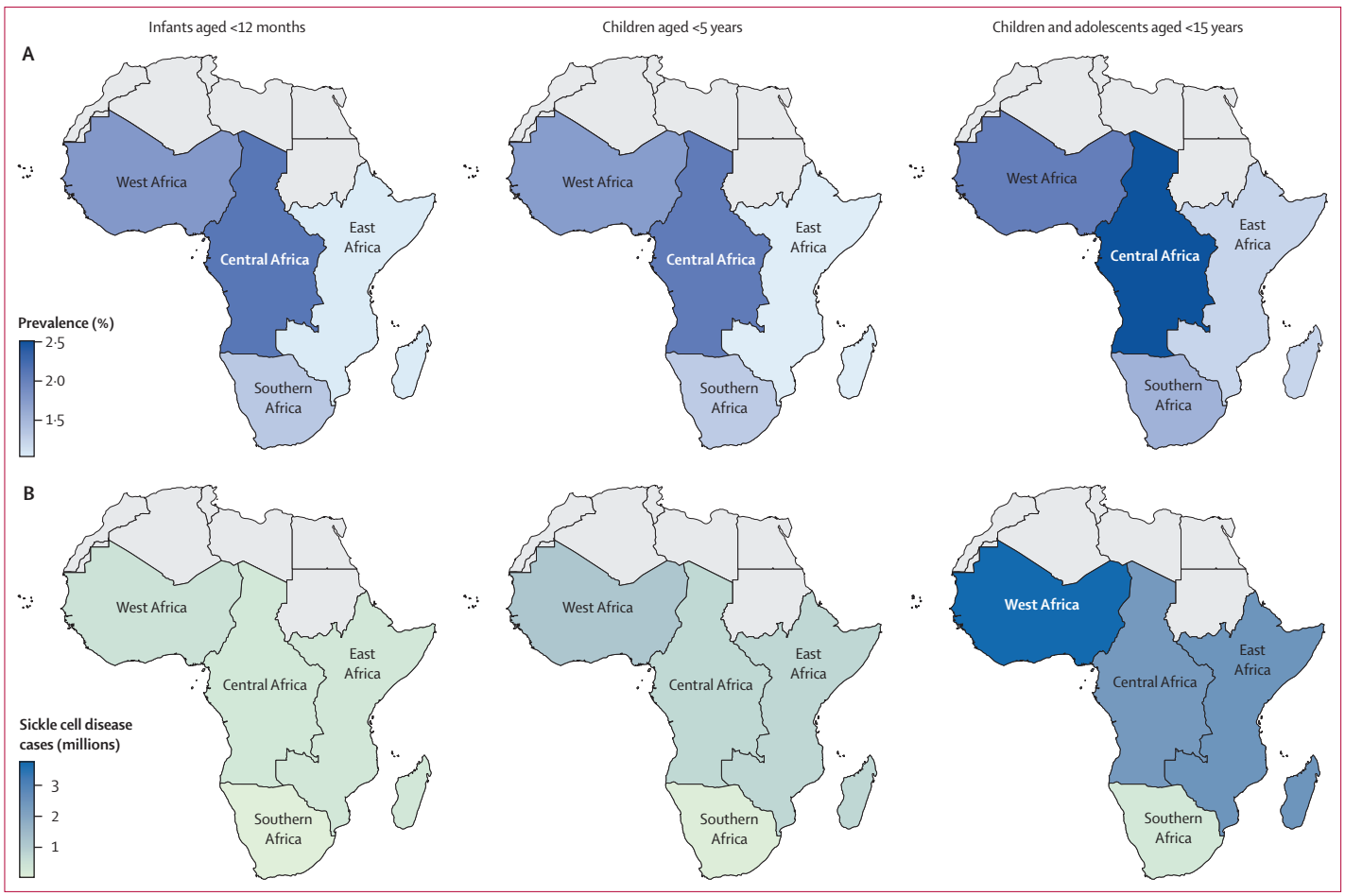

Figure 2: **Regional prevalence (A) and cases (B) of paediatric sickle cell disease in sub-Saharan Africa by age group (all sickle cell disease phenotypes)**

Botswana each contributed fewer than 10 000 cases in children younger than 5 years, while Eswatini (500 cases in children <5 years) and Lesotho (3800 cases in children <5 years) recorded the lowest estimates in the subregion (figure 3; appendix pp 24–50).

Discussion

This study builds on previous global modelling efforts by synthesising primary epidemiological evidence to generate country-level estimates across three paediatric age groups and key haemoglobin phenotypes, using a distinct modelling approach. We selected the three age groups to reflect biologically meaningful periods of early-life risk and to align with established child-health metrics. These age bands also correspond to crucial intervention points, including newborn screening, early-childhood survival monitoring, and the period during which prophylaxis and vaccination have substantial impact.[3] Across sub-Saharan Africa, the prevalence of all sickle cell diseases was high in early life, about 1·5% in infants and children younger than 5 years, and 1·8% in children and adolescents younger than 15 years. Phenotype-specific rates of HbSS were around 0·7% in infants and children younger than 5 years, and those of HbSC were around 0·3% in both age groups, with wide uncertainty and substantial heterogeneity across studies and settings. The wide confidence intervals reflect the sparse and heterogeneous evidence base, with many countries represented by few population-based studies and variation in design, age coverage, and diagnostic methods. Our modelling intentionally explored both within-study and between-country uncertainty, rather than constraining estimates to narrow intervals that would overstate precision in settings with insufficient surveillance.

We estimated that about 1·2 million infants, 2·8 million children younger than 5 years, and 8·9 million children and adolescents younger than 15 years were living with sickle cell disease in sub-Saharan Africa in 2023. Central Africa had the highest prevalence, while west Africa contributed the largest share of cases, followed by east, central, and southern Africa. Although sickle cell disease is present from birth and excess mortality is concentrated in early childhood in many settings in sub-Saharan Africa,[6,7] prevalence patterns derived largely from cross-sectional data might not directly reflect

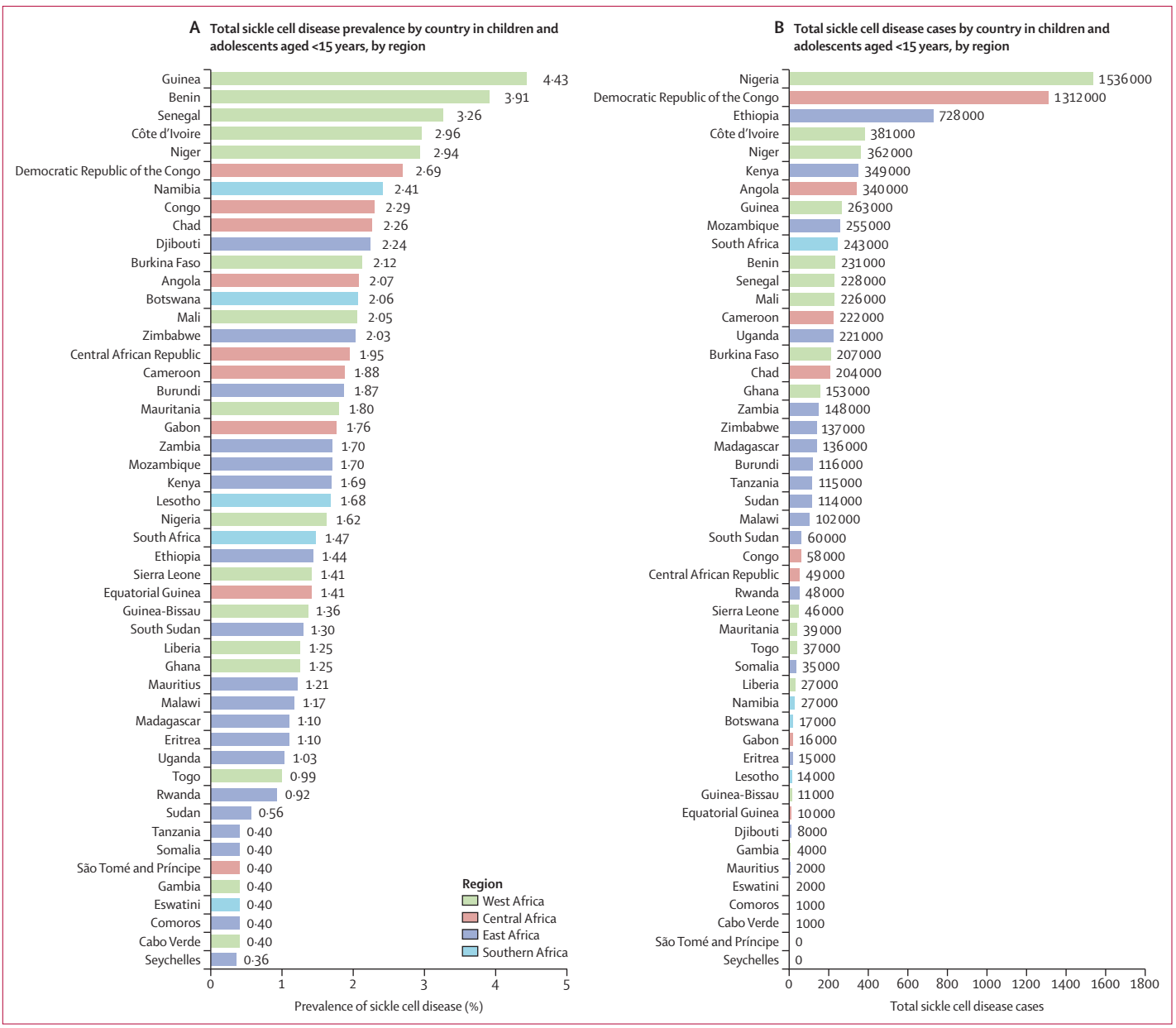

Figure 3: **Total sickle cell disease prevalence (A) and cases (B) by country for children and adolescents younger than 15 years**

survival trajectories. The slightly higher point estimates observed among children younger than 15 years compared with infants should not be interpreted as a true age-related increase in prevalence, because our estimates are largely derived from cross-sectional prevalence studies with heterogeneous sampling frames and diagnostic approaches. Additionally, in settings where newborn screening is uncommon, diagnosis in infancy is often delayed, and many affected infants could die before diagnosis or inclusion in studies.[5] By contrast, older children who survive infancy are more likely to have had contact with health services and received a confirmed diagnosis, increasing their likelihood of being captured in prevalence studies.[6] Malaria endemicity could further shape early mortality risks and health-system contact, indirectly influencing observed age-specific prevalence patterns.

Our country-level patterns underscore the concentration of the burden in populous, higher-prevalence countries—notably, Nigeria, the Democratic Republic of the Congo, and Ethiopia. By contrast, countries with a small population or lower prevalence such as Cabo Verde, Mauritius, and São Tomé and Príncipe contribute comparatively few cases, often with prevalence of 0·4% or lower and case counts in the hundreds rather than thousands. Despite lower absolute case numbers,

countries with small populations and fragile health systems could still face disproportionate challenges in delivering chronic sickle cell disease care, including planning newborn screening and prophylaxis.

When situating these findings against previous work, we note that our estimates differ in some aspects from those reported in GBD[2,15] and in an earlier modelling study by Piel and colleagues.[1] For example, the GBD 2023 report estimated 2·3 million sickle cell disease cases among children younger than 5 years in 2023, which is broadly comparable to our estimate for this age group (2·8 million).[15] However, the same study reported substantially lower estimates for infants (415 000 cases) and higher estimates for children younger than 15 years (4·2 million cases).[15] Although these estimates are still within our uncertainty intervals, variations are likely to reflect methodological differences rather than conflicting evidence. Whereas global models primarily estimate incidence at birth and project prevalence with age-structured survival assumptions, our analysis draws more directly on observed prevalence data among children, stratified by age and haemoglobin phenotype and synthesised with covariate-adjusted meta-regression. These approaches address related but distinct epidemiological questions and might therefore yield different estimates, particularly in settings where early mortality, delayed diagnosis, and inadequate surveillance complicate inference. These differences should not be viewed as contradictions, but as complementary perspectives highlighting uncertainty in paediatric sickle cell disease prevalence and the need for stronger population-based data. Moreover, Jonani and colleagues[16] reported an HbSS prevalence of 1·65% among children based on 53 studies. Direct comparison with our HbSS estimates (0·69% for children aged <5 years and 0·80% for children aged <15 years) is challenging, as their analysis did not clearly define the child age range and relied on simple pooling of crude study estimates.

Notwithstanding these variations, our estimates also align with previous syntheses and models in some key respects. For example, our pooled sub-Saharan Africa prevalence of 1·5% for infants and children younger than 5 years is comparable with Wastnedge and colleagues' 2018 global meta-estimate of birth prevalence for Africa at 1·13%.[7] Our regional patterns also align with those reported by Piel and colleagues,[1] whose maps showed high sickle cell disease burden at birth in west and central sub-Saharan Africa.[1,17] Furthermore, the high country-level estimates we reported in countries such as Nigeria, Democratic Republic of the Congo, Guinea, Benin, Cote d'Ivoire, and Niger are consistent with GBD 2021's listing of countries exceeding 1000–2000 per 100 000 livebirths,[2] with Piel and colleagues' projections indicating sustained high newborn sickle cell disease in Nigeria and the Democratic Republic of the Congo through 2050.[1] Conversely, countries in southern Africa, such as South Africa and Lesotho, reportedly have a relatively lower burden, which our absolute child cases also suggested,[18] although substantial within-country heterogeneity in the subregion warrants cautious interpretation, given the higher prevalence reported in some settings.[19]

Although we did not estimate hospital admissions or mortality, our high paediatric case estimates represent populations at substantial risk of preventable morbidity and mortality, particularly in settings where newborn screening is scarce, treatment access is patchy, and health-system capacity is inadequate.[6,20] Studies have suggested very high mortality from sickle cell disease in children younger than 5 years in sub-Saharan Africa, often without intervention, and contributing about 6–7% to all deaths in children younger than 5 years.[6,9] Findings from countries in east Africa such as Tanzania, with HbAS prevalence of about 13%, thousands of annual HbSS births, and high early mortality, illustrate how trait prevalence, birth cohorts, and health-system constraints interact to sustain the burden.[21] More broadly, the established evolutionary relationship between HbAS and malaria, reflected in high trait prevalence (often 10–40%) across many populations in sub-Saharan Africa, might help explain the regional concentration of sickle cell disease and the subregional patterns observed in this study.[22,23] The highest caseloads of malaria in Africa have been reported in Nigeria, Democratic Republic of the Congo, Uganda, and Ethiopia, where our country-specific sickle cell disease cases are also the highest.[24]

This study has important limitations. First, the geographical coverage of data was uneven, with west African countries contributing the majority of datapoints, while large areas of east and southern Africa were represented by sparse or hospital-based data. Only 10% of included datapoints originated from rural populations, despite most countries in sub-Saharan Africa having predominantly rural demographics, where many often have higher trait frequencies, inadequate diagnostic access, and poorer health-system reach. Moreover, several of the included studies, particularly from west and central Africa, were conducted more than 10–15 years ago. For countries where the most recent data predate 2010, prevalence estimates are likely to reflect past epidemiological patterns rather than contemporary dynamics. This imbalance probably contributes to underestimation of true prevalence and case numbers in some settings, as estimates for some countries rest more heavily on model extrapolation than on direct observation.

Second, relatively few newborn screening studies with appropriate denominators were available, which explains our inability to estimate birth prevalence. Although necessary, our focus on prevalence and absolute cases is insufficient for a complete picture of the sickle cell disease burden in sub-Saharan Africa. Additionally, our upper age limit of 15 years reflects the age ranges most commonly reported in available prevalence studies from sub-Saharan Africa. Although older adolescence

(15–19 years) is a crucial period for sickle cell disease management, this could not be examined separately due to insufficient and inconsistently reported data. Finer age stratification (eg, 1–5 years and 5–14 years) was also not feasible because most primary studies did not report prevalence in sufficiently granular age bands, although such data would be valuable for examining survival patterns.

Third, although outcome ascertainment was generally strong, and most studies used validated laboratory methods or standardised neonatal screening, participation and response rates were often poor or unreported, raising the likelihood of selection bias. Analytical approaches were typically basic, sufficient for crude prevalence but rarely adjusted for design effects or potential confounders. The relatively high contribution of non-HbSS genotypes in west and central Africa might also increase diagnostic and management complexity, particularly in settings relying on inadequate or non-confirmatory screening tools. Moreover, several model assumptions might have introduced additional uncertainty. The quadratic functional form for SDI and frequentist intervals might not fully capture non-linear or hierarchical risk patterns. Alternative approaches, such as Bayesian hierarchical models, could provide more robust uncertainty estimates. Population denominators from UN World Population Prospects and assumptions about subtype distributions were necessary but inevitably introduced further error margins. Inverse logit back-transformation is subject to Jensen's inequality;[25] however, because absolute prevalences are relatively low (0·4–3%), the induced bias is likely to be small. These choices are reasonable for the present synthesis, while more conservative alternatives (eg, restricted maximum likelihood, Hartung–Knapp, or likelihood-based generalised linear mixed-effects models) could be considered in future updates.

Finally, despite generally sound outcome ascertainment, the overall quality of the evidence base was moderate, with analytical approaches basic and rarely adjusted for design effects. Besides, we already noted that heterogeneity was substantial (high I^2 across most strata), which reflects variations in sampling frames, settings (urban *vs* rural), and diagnostic protocols, as well as true geographical differences in sickle cell disease frequency. Despite these uncertainties, our estimates sit within the envelope of previous global estimates and fill an important information gap for child-focused, phenotype-specific burden of sickle cell disease in sub-Saharan Africa, particularly at a time when countries are scaling essential services for newborn screening, penicillin prophylaxis, vaccination, hydroxyurea, and comprehensive care.

From a research and policy perspective, investment in population-representative surveillance and longitudinal cohorts is urgently needed, given the scarcity of data on long-term survival and intervention impact in many African settings. Innovative approaches such as embedding sickle cell disease testing into existing population surveys for malaria or HIV could provide scalable and affordable data collection.[6] The concentration of cases in a few high-burden countries, particularly Nigeria and the Democratic Republic of the Congo, means that even modest improvements in newborn screening, early prophylaxis (penicillin and malaria prevention), and vaccination coverage in these settings could avert hundreds of thousands of premature deaths.[1] Large-scale universal screening has been projected to save millions of lives globally, with up to 85% of beneficiaries present in sub-Saharan Africa.[1,26] Our results also highlight the neglected burden in countries with smaller populations, where sickle cell disease prevalence and cases are relatively lower; however, a seemingly greater health-system fragility that characterises such countries means the impact of the burden is felt more. In these contexts, targeted interventions, such as introducing low-cost point-of-care diagnostic kits, strengthening referral systems, and training community health workers in basic sickle cell disease management, could extend the reach of services to rural populations.[27] Home-based strategies through community health workers, including family education, nutritional advice, genetic counselling, and prophylaxis, have proven feasible in pilot settings.[28]

The WHO Regional Office for Africa's strategic guidance framework for sickle cell disease provides a structured referral pathway across all levels of the health system, which governments in sub-Saharan Africa can leverage.[29] For example, countries could consider prioritising sickle cell disease alongside other major childhood diseases with high morbidity and mortality. Such integrated interventions could include: scaling up of newborn and early-childhood screening, integrated into existing maternal and child health services;[20] expansion of access to affordable therapies, including penicillin, vaccines, and hydroxyurea, with careful monitoring to address toxicity concerns;[30] and strengthening of sickle cell disease treatment centres and primary health-care capacity, with attention to workforce distribution, equipment, and referral pathways.[9] Leveraging existing global health platforms such as UNICEF, the Global Fund to Fight AIDS, Tuberculosis and Malaria, and the US President's Emergency Plan For AIDS Relief (PEPFAR), remains relevant given their established country platforms and procurement systems; however, amid recent uncertainties in some bilateral and multilateral health financing, countries should strategically align sickle cell disease priorities within core child health mandates and increase domestic co-financing to ensure long-term sustainability.[30]

Although limited by data sparsity and methodological constraints, our study underscores the enormous and preventable burden of sickle cell disease in sub-Saharan Africa, particularly in west and central Africa, where the burden is disproportionately high. Implementation of evidence-based interventions, screening, prophylaxis,

comprehensive care, and equitable access to therapies could transform survival and quality of life for millions of African children. With timely policy reforms and investments, countries in sub-Saharan Africa can markedly reduce avoidable mortality and improve the lives of children living with sickle cell disease.

Contributors

DA conceived and designed the study. DA and AA conducted the literature searches. DA, AA, BMA, and JYT directly accessed and verified the underlying data. DA, BMA, and JYT reviewed the data and conducted the analysis. BMA developed all data visualisations. DA wrote the first draft. DA, AA, and IR contributed to the final draft and checked for important intellectual content. There were no restrictions on data access and all authors have critically reviewed and approved the final manuscript as submitted.

Declaration of interests

We declare no competing interests.

Data sharing

The underlying datasets are available upon reasonable request addressed to the corresponding author. All R and Python code used for the analysis can be accessed via the GitHub repository: https://tinyurl.com/afr-scd-gherg.

Acknowledgments

There was no funding source for this study.

References

1 Piel FB, Hay SI, Gupta S, Weatherall DJ, Williams TN. Global burden of sickle cell anaemia in children under five, 2010–2050: modelling based on demographics, excess mortality, and interventions. *PLoS Med* 2013; **10:** e1001484.

2 GBD 2021 Sickle Cell Disease Collaborators. Global, regional, and national prevalence and mortality burden of sickle cell disease, 2000–2021: a systematic analysis from the Global Burden of Disease Study 2021. *Lancet Haematol* 2023; **10:** e585–99.

3 WHO. Sickle cell disease. 2017. https://afro.who.int/health-topics/sickle-cell-disease (accessed Nov 12, 2025).

4 Brown B, Long K, Agdere L, et al. The association between vitamin D deficiency and hospitalization outcomes in pediatric patients with sickle cell disease. Blood Cells Mol Dis 2020; 82: 102415.

5 Adigwe OP, Onoja SO, Onavbavba G. A critical review of sickle cell disease burden and challenges in sub-Saharan Africa. *J Blood Med* 2023; **14:** 367–76.

6 Grosse SD, Odame I, Atrash HK, Amendah DD, Piel FB, Williams TN. Sickle cell disease in Africa: a neglected cause of early childhood mortality. *Am J Prev Med* 2011; **41** (suppl 4)**:** S398–405.

7 Wastnedge E, Waters D, Patel S, et al. The global burden of sickle cell disease in children under five years of age: a systematic review and meta-analysis. *J Glob Health* 2018; **8:** 021103.

8 Colombatti R, Birkegard C, Medici M. Global epidemiology of sickle cell disease: a systematic literature review. *HemaSphere* 2022; **6** (suppl 3)**:** 3826.

9 Esoh K, Wonkam-Tingang E, Wonkam A. Sickle cell disease in sub-Saharan Africa: transferable strategies for prevention and care. *Lancet Haematol* 2021; **8:** e744–55.

10 Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021; **372:** n71.

11 Stevens GA, Alkema L, Black RE, et al, and The GATHER Working Group. Guidelines for accurate and transparent health estimates reporting: the GATHER statement. *Lancet* 2016; **388:** e19–23.

12 von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, and the STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol* 2008; **61:** 344–49.

13 Yuan C, Adeloye D, Luk TT, et al, and the Global Health Epidemiology Research Group. The global prevalence of and factors associated with *Helicobacter pylori* infection in children: a systematic review and meta-analysis. *Lancet Child Adolesc Health* 2022; **6:** 185–94.

14 Adeloye D, Song P, Zhu Y, Campbell H, Sheikh A, Rudan I, and the NIHR RESPIRE Global Respiratory Health Unit. Global, regional, and national prevalence of, and risk factors for, chronic obstructive pulmonary disease (COPD) in 2019: a systematic review and modelling analysis. *Lancet Respir Med* 2022; **10:** 447–58.

15 GBD 2023 Disease and Injury and Risk Factor Collaborators. Burden of 375 diseases and injuries, risk-attributable burden of 88 risk factors, and healthy life expectancy in 204 countries and territories, including 660 subnational locations, 1990–2023: a systematic analysis for the Global Burden of Disease Study 2023. *Lancet* 2025; **406:** 1873–922.

16 Jonani B, Kasule EC, Herman BR, et al. Burden of sickle cell anemia in Africa: a systematic review and meta-analysis. *PLoS One* 2025; **20:** e0337090.

17 Piel FB, Howes RE, Patil AP, et al. The distribution of haemoglobin C and its prevalence in newborns in Africa. *Sci Rep* 2013; **3:** 1671.

18 Wonkam A, Ponde C, Nicholson N, Fieggen K, Ramessar R, Davidson A. The burden of sickle cell disease in Cape Town. *S Afr Med J* 2012; **102:** 752–54.

19 Wonkam A, Kengne AP. Modelling the mortality of sickle cell disease in Africa. *Lancet Haematol* 2021; **8:** e677–78.

20 Ismail A, Inusa BP. Effectiveness of comprehensive newborn screening program of sickle cell disease on the childhood morbidity and mortality of the disease: a systematic review and meta-analysis. *Blood* 2020; **136** (suppl 1)**:** 11.

21 Musyoka AM, Zebedayo K, Mmbaga BT. Prevalence of sickle cell disease among anaemic children attending Mbeya Referral Hospital in southern Tanzania. *East Afr Health Res J* 2018; **2:** 142–46.

22 Elguero E, Délicat-Loembet LM, Rougeron V, et al. Malaria continues to select for sickle cell trait in Central Africa. *Proc Natl Acad Sci USA* 2015; **112:** 7051–54.

23 Piel FB, Patil AP, Howes RE, et al. Global distribution of the sickle cell gene and geographical confirmation of the malaria hypothesis. *Nat Commun* 2010; **1:** 104.

24 Venkatesan P. WHO world malaria report 2024. *Lancet Microbe* 2025; **6:** 101073.

25 Merhav N. Reversing Jensen's inequality for information-theoretic analyses. *Information* 2022; **13:** 39.

26 Grosse SD, Olney RS, Baily MA. The cost effectiveness of universal versus selective newborn screening for sickle cell disease in the US and the UK: a critique. *Appl Health Econ Health Policy* 2005; **4:** 239–47.

27 Adegoke SA, Abioye-Kuteyi EA, Orji EO. The rate and cost of hospitalisation in children with sickle cell anaemia and its implications in a developing economy. *Afr Health Sci* 2014; **14:** 475–80.

28 Nicole AYA, Charlotte EE, Shanti NC, et al. Administration of analgesics at home for the treatment of vaso-occlusive crises before admission to hospital. *Pan Afr Med J* 2020; **37:** 127 (in French).

29 WHO African Region. WHO SICKLE package of interventions for sickle cell disease management: strategic guidance framework module 1. Noncommunicable Diseases (UCN) Cluster, WHO Regional Office for Africa. 2024. https://www.afro.who.int/sites/default/files/2024-06/Module%201_Strategic%20Guidance%20Framework.pdf (accessed Nov 14, 2025).

30 Zhou AE, Travassos MA. Bringing sickle-cell treatments to children in sub-Saharan Africa. *N Engl J Med* 2022; **387:** 488–91.