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Determinants of diarrhoeal diseases among under-five children in Africa (2013–2023): a comprehensive systematic review highlighting geographic variances, socioeconomic influences, and environmental factors

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Abstract

Background Diarrhea diseases continue to present a significant threat to the well-being of children under the age of five in Africa, thereby contributing substantially to both morbidity and mortality rates. The period spanning between January 2013 and December 2023 has witnessed persistent challenges in the fight against these diseases, thereby necessitating a thorough investigation into the factors that determine their occurrence. It is important to note that the burden of diarrhea diseases is not evenly distributed across the continent, with residence, socioeconomic, and environmental factors playing pivotal roles in shaping the prevalence and incidence rates. Consequently, this systematic review aimed to consolidate and analyze the existing body of literature on the determinants of diarrhea diseases among children under the age of five in Africa between January 2013 and December 2023.

Method The systematic review employed a rigorous methodological approach to examine the determinants of diarrhea diseases among children under the age of five in Africa between January 2013 and December 2023. A comprehensive search strategy was implemented, utilizing databases such as PubMed, Scopus, and Web of Science, and incorporating relevant keywords. The inclusion criteria focused on studies published within the specified timeframe, with a specific focus on the determinants of diarrhea disease among children under the age of five in Africa. The study selection process involved a two-stage screening, with independent reviewers evaluating titles, abstracts, and full texts to determine eligibility. The quality assessment, employing a standardized tool, ensured the inclusion of studies with robust methodologies. Data extraction encompassed key study details, including demographics, residence factors, socioeconomic influences, environmental variables, and intervention outcomes.

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Results The search yielded a total of 12,580 articles across 25 African countries; however, only 97 of these articles met the inclusion criteria and were ultimately included in the systematic review. The systematic review revealed geographic and seasonal disparities in the prevalence of diarrhoeal diseases across different countries in Africa. Factors such as age-related vulnerabilities, gender disparities, maternal occupation, disposal of young children's stools, and economic status were identified as significant determinants of the prevalence of diarrhea disease.

Conclusion This systematic review provides a comprehensive understanding of the determinants of diarrhea diseases among children under the age of five in Africa between January 2013 and December 2023. The nuanced analysis of residence variations, socioeconomic influences, environmental factors, and intervention outcomes underscores the complex nature of this issue. The findings highlight the necessity for region-specific and context-sensitive interventions to address the unique challenges faced by diverse communities. This review serves as a valuable resource for policymakers, healthcare professionals, and researchers, guiding the development of evidence-based strategies aimed at reducing the burden of diarrhea diseases and improving child health outcomes in Africa.

Keywords Diarrhea, Diarrhoeal diseases, Under-five, Children, Pediatric, Determinants, Risk factors, Africa

Background

Diarrhoeal diseases pose a persistent threat to the health of children under five, particularly in low- and middle-income countries [1]. In Africa, this challenge is notably severe, with an alarming number of reported cases annually [2]. According to the World Health Organization (WHO), diarrhoeal diseases account for a substantial proportion of child mortality across the continent [3, 4]. This emphasizes the imperative need for comprehensive understanding and targeted interventions. Despite advancements in Africa, these diseases remain a significant public health challenge, disproportionately affecting vulnerable populations like under five children due to limited access to clean water, sanitation, and adequate healthcare resources [5, 6].

Between January 2013 and December 2023, like other parts of the world, Africa underwent substantial socioeconomic, environmental, and healthcare transformations crucial for contributing to the reduction of diarrheal diseases [7, 8]. The transition encompasses research efforts, the expansion of higher education institutions [9], enhanced water accessibility, the promotion of good hygiene practices, improved access to sanitation facilities, all supported by United Nations Children's Fund (UNICEF), WHO and other nongovernmental organizations. [7] These transitions potentially influenced the determinants and prevalence of diarrhoeal diseases among children under five. However, rapid urbanization, sustainability problems, climate fluctuations, and varying healthcare infrastructures have shaped the disease landscape [10]. Disparities in economic development and resource access among African nations have resulted in differing disease burdens [11] including under-five children. Understanding the determinants of diarrhoeal diseases is fundamental for designing effective public health interventions a head of time [12]. Investigating multifaceted factors contributing to these diseases among under-five children in Africa holds significant importance, not only for healthcare providers and policymakers but also for global health initiatives [13].

The systematic review on diarrhoeal diseases will help understand crucial aspects of how these diseases affect under-five children in Africa. Evidences from various studies indicated the existence of common factors and national variations of diarrhoeal diseases due to socioeconomic strata and environmental conditions difference. Moreover, a comprehensive examination of these determinants can shed light on the impact of public health policies and interventions on disease prevalence and outcomes over time [14]. Synthesizing findings from diverse studies was not only offer a comprehensive overview but also enable the identification of factors through time [15]. These factors could highlight areas needing further research attention or where interventions might be most impactful.

Rationale

Through a systematic review between January 2013 and December 2023, this review aims to provide a comprehensive synthesis of current knowledge. It seeks to address existing gaps and offer insights critical for targeted interventions and policy formulation. The rationale for selecting the period between January 2013 and December 2023 for this systematic review is to capture the most recent and relevant data on the determinants of diarrheal diseases among under-five children in Africa. This timeframe allows for the inclusion of studies conducted after the implementation of several major public health initiatives and interventions aimed at improving child health and reducing diarrheal diseases in the region. By focusing on this period, the review aims to provide an up-to-date understanding of the current trends, emerging determinants, and the effectiveness of recent policies and interventions, ensuring that the findings are relevant to contemporary public health strategies and practices.

Method

Search strategies

A systematic search was conducted across major academic databases, including PubMed, MEDLINE, Scopus, and Web of Science, utilizing a combination of keywords related to diarrhoeal diseases, under-five children, Africa, determinants, and interventions. Studies published between January 2013 and December 2023 were included to capture the most recent and relevant information. Eligibility criteria were defined to ensure the selection of high-quality studies, including peer-reviewed articles, systematic reviews, and meta-analyses.

A systematic search was conducted across major academic databases, including PubMed, Scopus, Web of Science, Embase, Google scholar, MEDLINE, and Cochrane Library utilizing a combination of keywords "diarrhea," "Diarrhoea," "under-five children," "Africa," "determinants," "Risk Factors", "Preschool Children", "child health," "socioeconomic factors," and "water sanitation," search terms used in collecting relevant articles. Authors use Boolean operators (AND, OR) to combine keywords and phrases for effective searches. That was ("Diarrhea"[Mesh]OR"Diarrhoeal Diseases"[Mesh] OR"Diarrhea"OR"Diarrhoea"AND ("Child"[Mesh] OR"Pediatrics"[Mesh]OR"Under-Five" OR"Children" AND ("Determinants" [Mesh]OR"RiskFactors"[Mesh] OR"Epidemiology"[Mesh]OR"Causality"[Mesh]OR "Determinants" OR "Risk Factors" OR "Causality" AND "Africa". Only English language was used to filters out and retrieve relevant studies published within this specified timeframe.

Screening of eligible studies

Initial screening by titles and abstracts based on predefined inclusion criteria done by two team members (EA and JA) independently. Then disparities were resolved by discussion with other team member (AM) and agreements reached on the included articles for full texts screening. Exclude studies that clearly do not meet the scope of the review. Then we obtain and review the full texts of potentially relevant articles identified in the initial screening (by titles and abstracts) to assess their eligibility based on inclusion/exclusion criteria. The full text retrieved by other two reviewers (JA and EA) independently. Again, discrepancies were solved through discussion with other team member (HF). Then the search results were reported based on the Preferred Reporting Items for Systematic Review and Meta-analysis statement (PRISMA) guideline.

Inclusion and exclusion criteria

Articles any study design, done in African countries, focused at children under five, and on determinants of diarrhoeal diseases were included under this systematic review. Studies with inadequate or unclear methodologies, studies not focusing on determinants, reviews without original data, and studies not involving under-five children were excluded. Studies other than English language also were excluded.

Data extraction

Extraction of relevant data from included studies using a predefined template. Title, first author, country, publication year, study design, sample size, prevalence and study period were the data extracted from each study.

Study quality assessment

In this systematic review, quality evaluation involved scrutinizing the methodological rigor and risk of bias of the included studies. The Newcastle-Ottawa Scale was used to appraise the quality of each study. Two independent reviewers assessed various aspects of each study, such as the clarity of the research aims, appropriateness of the methodology and research design, recruitment strategy, data collection method, researcher-participant relationship, ethical considerations, data analysis, statement of findings, and overall value of the research [16]. Discrepancies encountered during the evaluation process were resolved through thorough discussion among the reviewers. If required, the perspective of a third reviewer was sought to ensure a comprehensive and unbiased resolution. The methodological quality of each study included in the analysis was meticulously assessed, employing a rating system that categorized studies as very good (9–10 points), good (7–8 points), satisfactory (5–6 points), or unsatisfactory (0–4 points). Then based on modified Newcastle-Ottawa Scale (NOS) specifically tailored for cross-sectional studies was utilized. Studies with a score of ≥ 7 out of 10 on this scale were deemed to have achieved high methodological quality [17]. Consequently, only studies falling within the categories of good and very good quality, as per the established rating criteria, were considered for inclusion in the final analysis. It is noteworthy that studies rated as very good quality, indicating a higher level of methodological rigor, were given special attention and were ultimately included in the conclusive analysis. This meticulous approach ensures that only studies meeting stringent quality standards contribute to the overall findings and conclusions of the research.

Synthesis of findings

The phase of data synthesis in the systematic review encompassed a meticulous and comprehensive procedure to amalgamate findings from a variety of studies pertaining to the factors that contribute to cases of diarrhea diseases among children under the age of five in Africa between January 2013 and December 2023. The

qualitative synthesis furnished valuable insights into the contextual intricacies of these determinants, thereby illuminating the socioeconomic, breastfeeding and nutrient intake, and environmental aspects that exert an influence on diarrhea diseases. Consequently, a thematic analysis was conducted to identify recurring themes across the studies. This entailed extracting and categorizing data that pertained to similar determinants in order to facilitate a structured synthesis.

The approach used to estimate the overall pooled prevalence of diarrheal diseases involved conducting a systematic review of studies focusing on children under 5. The review compiled and synthesized prevalence from the data reported in each study, providing a comprehensive overview of diarrheal disease burden across different countries during the specified timeframe. The overall pooled prevalence and other analysis were subsequently estimated using Stata Version 17. In this review, the authors addressed heterogeneity by conducting subgroup analyses that grouped studies according to factors such as geographical variation, publication year, study season, study setting, sample size, and study design. This approach allowed to explore variations in effect size based on these characteristics.

Protocol registration

The review protocol was registered with the PROSPERO database through a registration number (PROSPERO- CRD42024500697).

Results

Search results

By searching through different electronic websites, a total of 12,580 were identified. After screening and retrieving the systematic review finally encompassed a 97 pertinent studies published across African nations between January 2013 and December 2023 (Fig. 1).

Study characteristics

The studies included a range of sample sizes, from a maximum of 30,066 in Nigeria [18] to a minimum of 300 in North Sudan [19]. The overall 338,222 individuals in 25 African countries were included in the systematic review (Table 1; Fig. 2) The overall pooled prevalence of

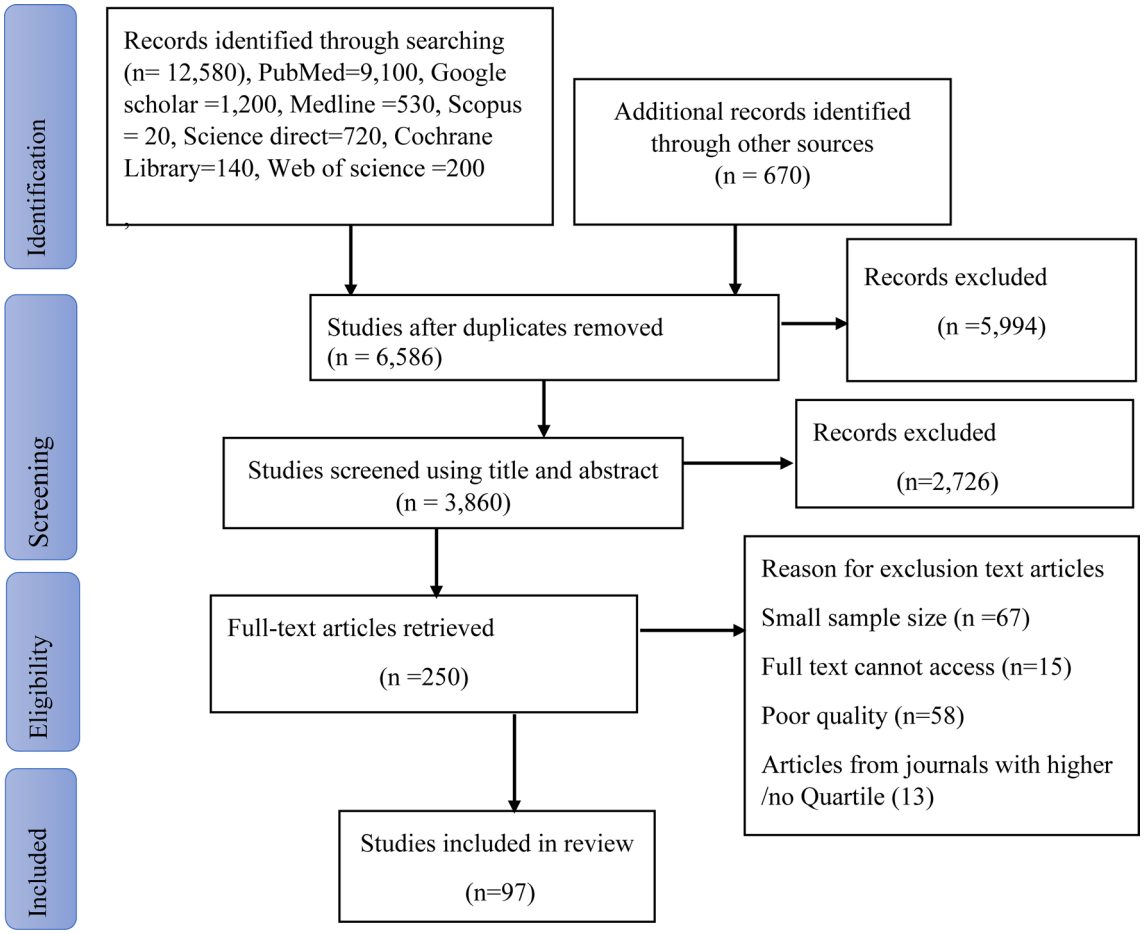

Fig. 1 PRISMA flow diagram for selection of studies in determinants of diarrhoea disease in Africa

Table 1 Extracted data among included studies in systematic review of diarrhoeal disease determinants among under-five children in Africa (2013–2023)

Authors, Year	Country	Setting	Sample size	Study design	Prevalence	Study area
Tadesse et al., 2022	Ethiopia	Community-based	556	Cross-sectional	26.8	Rural
Getahunet al., 2021	Ethiopia	Community-based	485	Cross-sectional	17.6	Urban
Mohammed et al., 2013	Ethiopia	Community-based	590	Cross-sectional	30.5	Rural
Natnael et al., 2021	Ethiopia	Community-based	340	Cross-sectional	11	Semi-Urban
Kombat et al., 2014	Ghana	Population survey	2,547	Cross-sectional	11.7	Both
Girmay et al., 2023	Ethiopia	Community-based	1,807	Cross-sectional	14.8	Urban
Rukambile et al., 2020	Tanzania	Community-based	493	Cross-sectional		Rural
Bitew et al., 2023	Ethiopia	Community-based	422	Cross-sectional	24.9	Semi-Urban
Godana et al., 2013	Ethiopia	Community-based	612	Case-control	24	Rural
Nantege et al., 2022	Uganda	Community-based	384	Cross-sectional	37.6	Semi-Urban
Mebrahtom et al., 2022	Ethiopia	Community-based	305	Case-control		Both
Asgedom et al., 2023	Ethiopia	Community-based	4,381	Cross-sectional	25.5	Both
Thiam et al., 2017	Senegal	Community-based	596	Cross-sectional	26	Both
Omona et al. 2020	Uganda	Community-based	244	Cross-sectional	29.1	Both
Mulatu et al., 2022	Ethiopia	Population survey	6,261	Prospective cohort	41.75	Both
Birhan et al., 2023	Ethiopia	Community-based	717	Cross-sectional	29	Rural
Workie et al., 2019	Ethiopia	Community-based	614	Cross-sectional	32.1	Rural
Gizaw et al., 2017	Ethiopia	Community-based	367	Cross-sectional	31.3	Both
Melese et al., 2023	Ethiopia	Community-based	400	Cross-sectional	20.8	Both
Soboksa et al., 2020	Ethiopia	Community-based	396	Case-control		Both
Anteneh et al., 2017	Ethiopia	Community-based	775	Cross-sectional	21.5	Both
Gebru et al., 2014	Ethiopia	Community-based	792	Cross-sectional	16	Both
Mihrete et al., 2014	Ethiopia	Community-based	925	Cross-sectional	22.05	Both
McClelland et al., 2022	Tanzania	Community-based	779	Cross-sectional	32.1	Rural
Pickering et al., 2015	Mali	Community-based	4,532	CRT		Rural
Woldu et al., 2016	Ethiopia	Community-based	704	Cross-sectional	26.1	Rural
Hashi et al., 2016	Ethiopia	Community-based	498	Cross-sectional	14.5	Urban
Baye et al., 2021	Ethiopia	Community-based	357	Case-control		Urban

Table 1 (continued)

Authors, Year	Country	Setting	Sample size	Study design	Prevalence	Study area
Alemayehu et al., 2020	Ethiopia	Community-based	722	Cross-sectional	23.5	Rural
Siziya et al., 2013	N.Sudan	Community-based	23,295	Cross-sectional	28.2	Both
Bushen et al., 2022	Ethiopia	Community-based	846	CRT		Both
Wasihun et al., 2018	Ethiopia	Community-based	610	Cross-sectional	27.2	Rural
Machava et al., 2022	Mozambique	Community-based	300	Cross-sectional	33.3	Both
Akinyemi et al., 2019	Nigeria	Community-based	882	Cross-sectional	7.5	Both
Asfaha et al., 2018	Ethiopia	Community-based	600	Case-control	14.18	Both
Tambe et al., 2015	Cameroon	Community-based	602	Cross-sectional	23.8	Urban
Mengistie et al., 2013	Ethiopia	Community-based	530	Cross-sectional	14.6	Urban
Melese et al., 2019	Ethiopia	Community-based	537	Cross-sectional	13.6	Both
Soboksa et al., 2021	Ethiopia	Community-based	9,916	Cross-sectional	11	Both
Kefalew et al., 2021	Ethiopia	Community-based	620	Cross-sectional	24	Both
Dagnew et al., 2019	Ethiopia	Community-based	498	Cross-sectional	14.5	Urban
Mengistie et al., 2013	Ethiopia	Community-based	849	CRT		Rural
Mernie et al., 2022	Ethiopia	Community-based	672	Cross-sectional		Rural
Nwokoro et al., 2020	Nigeria	Community-based	469	Cross-sectional	10.77	Rural
Diouf et al., 2014	Burundi	Community-based	903	Cross-sectional	32.6	Rural
Colombo et al., 2023	Côte d'Ivoire	Community-based	567	Cross-sectional	27	Urban
Cha et al., 2017	DR Congo	Community-based	720	CRT		Both
Hassan et al., 2014	Egypt	Community-based	348	Prospective cohort		Rural
MANSOUR et al., 2013	Egypt	HI	800	Case-control		Urban
Danquah et al., 2014	Ghana	Community-based	378	Cross-sectional	13	Urban
Asare et al., 2022	Ghana	HI		Cross-sectional		Both
Cha et al., 2015	Ghana	Community-based	600	CRT		Rural
Seidu et al., 2013	Ghana	Community-based	1,431	Cross-sectional		Semi-Urban
Afitiri et al., 2020	Ghana	Community-based	15,808	Cross-sectional		Both
Kombat et al., 2024	Ghana	Community-based	2,547	Cross-sectional	11.7	Both
Naah et al., 2019	Ghana	Community-based	4,821	Cross-sectional	18	Both

Table 1 (continued)

Authors, Year	Country	Setting	Sample size	Study design	Prevalence	Study area
Abu et al., 2018	Ghana	Community-based	401	Cross-sectional	18	Urban
Apanga et al., 2021	Ghana	Population survey	8,879	Cross-sectional	17	Urban
Raza et al., 2020	Mozambique	Community-based	13,745	Cross-sectional	11.1	Both
Knee et al., 2021	Mozambique	Community-based	922	CRT		Urban
Guillaume et al., 2020	Kenya	Community-based	324	Cross-sectional	18.7	Semi-Urban
Fagbamigbe et al., 2017	Nigeria	Community-based	13,322	Cross-sectional	13	Both
Onyearugha et al., 2020	Nigeria	HI	890	Prospective cohort	11.2	Both
Yaya et al., 2018	Nigeria	Community-based	28,596	Cross-sectional	11.3	Both
Nwaoha et al., 2016	Nigeria	HI	600	Case-control		Both
Getahun et al., 2023	Ethiopia	HI	447	Case-control		Urban
Ntshangase et al., 2022	South Africa	Community-based	506	Cross-sectional	67.3	Urban
Birungi et al., 2016	Uganda	Community-based	367	Cross-sectional	33	Both
Hirai et al., 2016	Uganda	Community-based	7,019	Cross-sectional		Both
Nantege et al., 2022	Uganda	Community-based	384	Cross-sectional	62.4	Semi-Urban
Kapwata et al., 2018	South Africa	Community-based	408	Cross-sectional	20	Semi-Urban
Nguyen et al., 2021	South Africa	Community-based	707	Cross-sectional	15.3	Semi-Urban
Claudine et al., 2021	Rwanda	Population survey	7,474	Cross-sectional	12.7	Both
Evans et al., 2021	Madagascar	Community-based	1,600	Cross-sectional		Rural
Bennion et al., 2021	Tanzania	Community-based	9,996	Cross-sectional	23.2	Both
Rukambile et al., 2023	Tanzania	Community-based	340	MM	22.2	Rural
Nwokoro et al., 2018	Nigeria	Community-based	534	Cross-sectional	10.77	Rural
Samwel et al., 2014	Kenya	Population survey	3,838	Cross-sectional		Both
Bah et al., 2022	Sierra Leone	Community-based	1,002	Cross-sectional	12.3	Both
Atari et al., 2021	South Sudan	Population survey	8,338	Cross-sectional	19	Both
Nsubuga et al., 2022	Uganda	HI	579	Case-control		Both
Daffe et al., 2022	Senegal	Community-based	10,851	Cross-sectional	18.16	Both
Moon et al., 2019	Malawi	Population survey	14,872	Cross-sectional	20	Both
Siziya et al., 2013	N.Sudan	Population survey	23,295	Cross-sectional		Both

Table 1 (continued)

Authors, Year	Country	Setting	Sample size	Study design	Prevalence	Study area
Thiam et al., 2017	Senegal	Community-based	596	Cross-sectional	26	Both
Awoniyi et al., 2021	Nigeria	Population survey	30,068	Cross-sectional	12.9	Both
Elmanssury et al., 2022	N.Sudan	Community-based	311	Cross-sectional	35	Rural
Netsereab et al., 2017	N.Sudan	Population survey	14,081	Cross-sectional	26.9	Both
Davies et al., 2014	N.Sudan	Community-based		Cross-sectional		Both
Jayte et al., 2023	Somalia	IDPs	318	Cross-sectional	16.7	IDPs
Chilambwe et al., 2015	Zambia	Community-based	718	Cross-sectional	44.6	Urban
Oyedele et al., 2023	Zambia	Population survey	4,786	Cross-sectional	16.88	Both
Dharod et al., 2021	Cameroon	Population survey	2,129	Cross-sectional	32.3	Rural
Lanyero et al., 2021	Uganda	Community-based	856	Cross-sectional	37.1	Rural
Aderinwale et al., 2023	Chad	Population survey	16,710	Cross-sectional	19.7	Both
William et al., 2022	South Sudan	Community-based	439	Cross-sectional	64.2	
Chari et al., 2023	Zimbabwe	HI	386	Cross-sectional	25.1	

Key: Black space = for studies not reporting sample size and/or prevalence, HI = Health Institution Based, CRT = Cluster Randomized Controlled Trial

diarrhoeal diseases among under-five children in Africa is estimated to be 16.886% with 95% CI (16.747, 17.025) with the range of 7.500% from Nigeria [20] to 67.300% at South Africa [21] during this specified period.

Heterogeneity assessment

Due to the diversity in the time periods, geographic locations, sample sizes, season of study and study designs of the included studies, significant heterogeneity in prevalence of diarrheal disease was observed (Cochran's Q Test p-value = 0.00, I^2 = 99.30%). Significant regional variations are comprehended, with East Africa (I^2 = 99.25%) and Southern Africa (I^2 = 99.89%) exhibiting the highest heterogeneity. These findings point to significant regional variations in the prevalence of diarrheal illnesses. According to the overall test for regional differences, which is highly significant (Q_b = 43.36, $p < 0.001$), regional factors have a large impact on diarrheal disease estimates. Study settings may have an impact on prevalence estimates, according to the significant test for setting differences (Q_b = 17.95, $p < 0.001$). Lastly, the analysis shows considerable variety by season, with spring having very little variability, minimal impact sizes, and mixed and summer seasons displaying high effect sizes and heterogeneity (Table 2).

Synthesized findings on determinants of diarrhoeal diseases among under-five children

Synthesizing the data from various investigations on diarrhea illnesses among children under the age of five in Africa between January 2013 and December 2023 revealed both similarities and differences. Twenty-three determinants consistently displayed connections with diarrhea diseases across multiple investigations, emphasizing their significant roles in disease incidence. Factors such as limited access to uncontaminated water, inadequate sanitation facilities, and low socio-economic status were recurring themes contributing to the prevalence of diarrhea diseases in this population.

However, the synthesis also exposed disparities among the investigations regarding the impacts of certain determinants. While most of the factors displayed consistent connections with diarrhea diseases across different circumstances, others demonstrated situation-specific effects. This variability underscores the intricate interplay of environmental, socio-economic, and cultural factors influencing the dynamics of diarrhea diseases in diverse African settings (Table 3).

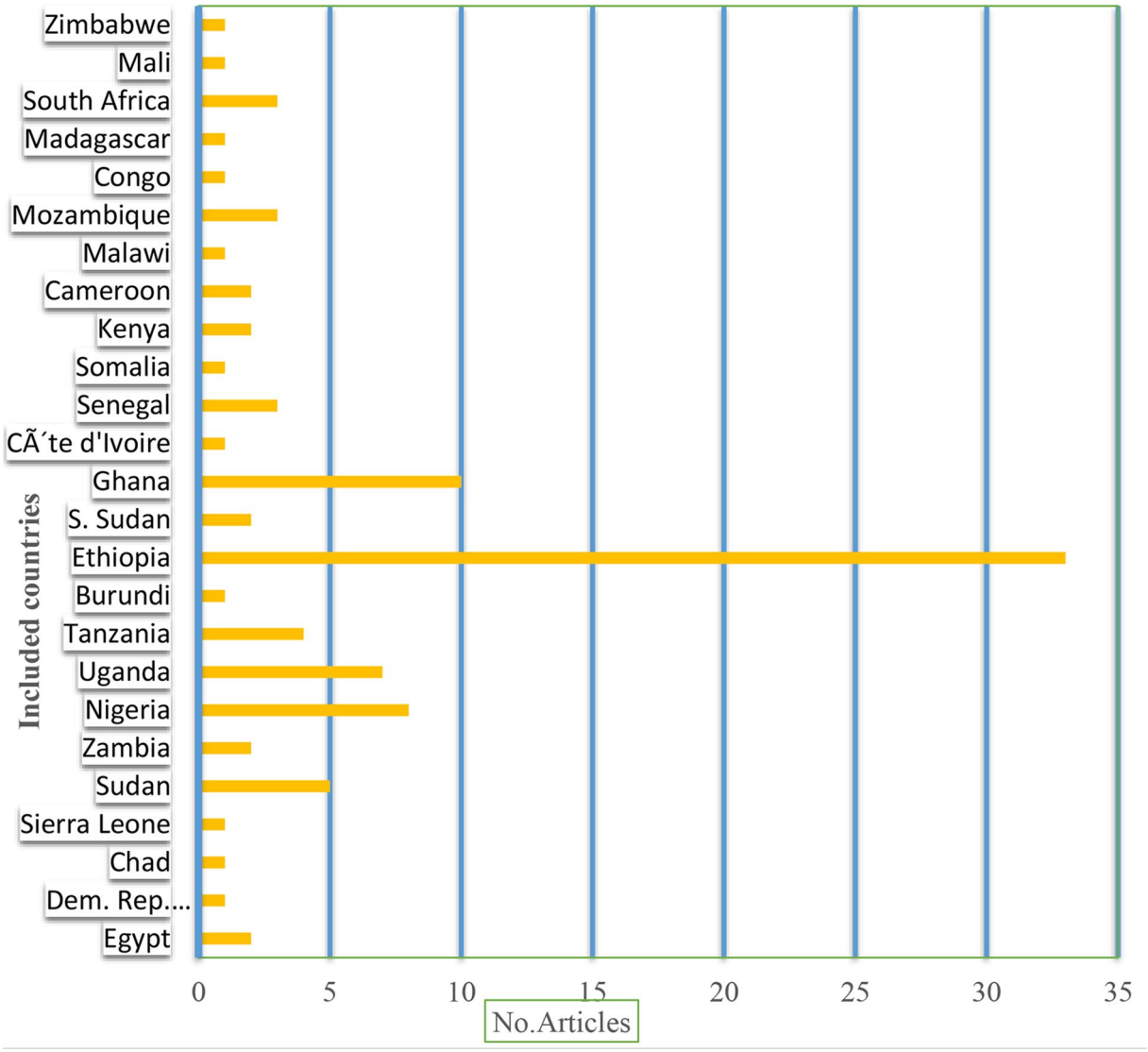

Fig. 2 African countries included in the systematic review of diarrhoeal disease determinants

Discussion

The aim of this systematic review is to gain a comprehensive understanding of the persistent and predominant factors that contribute to diarrhea among children under the age of five in Africa. Factors such as age-related vulnerabilities, gender disparities, maternal occupation, the method of stool disposal by young children, economic influences, and environmental factors collectively contribute to the prevalence of diarrhea diseases. All these factors were themed after assessing from included studies. The economic status of households emerges as a critical determinant in the prevalence of diarrhoeal diseases among children under the age of five in Africa. This trend was consistently observed across 12 articles focusing on the wealth status of households [18, 19, 22–31]. Potential explanation for this correlation is that poverty, characterized by limited access to vital resources such as clean water, sanitation, and healthcare, functions as a significant risk factor [109]. The other reason could be families with lower income often encounter difficulties in providing adequate nutrition, maintaining hygiene, and ensuring timely medical care, thereby increasing children's vulnerability to diarrhoeal infections. Economic constraints frequently impede access to healthcare services, including vaccination programs and medical treatment, amplifying the severity and duration of diarrhoeal episodes [110].

Another 25 studies suggests that maternal education significantly influences the prevalence of diarrhoeal diseases among children under the age of five in Africa [19, 24, 27, 29, 32–53]. It appears that a mother's level of education is intricately linked to the overall well-being of her child, as educated mothers tend to adopt healthier practices. The other possible explanation for

Table 2 Subgroup analysis of diarrheal disease prevalence based on regional, temporal, setting, and seasonal variations

Subgroup	Category	*N* (df)	Q	*P* > Q	τ^2	I^2 (%)	H_2
By Region	Central Africa	2	144.5	0.001	41.218	98	50.02
	East Africa	40	3911.89	0.001	131.476	99.25	133.17
	North Africa	2	14.69	0.001	10.996	98.03	50.67
	Southern Africa	7	1372.47	0.001	359.635	99.89	909.15
	West Africa	17	676.85	0.001	30.439	99.27	136.34
	Overall	72	10140.77	0.001	139.783	99.72	360.90
Test of group differences: Q_b = chi2(4) = 43.36 Prob > Q_b = 0.000							
By Year	2013	3	82.59	0.001	46.675	96.83	31.53
	2014	5	288.88	0.001	86.901	98.26	57.32
	2015	1	67.04	0.001	213.093	98.51	67.04
	2016	2	48.71	0.001	83.298	96.07	25.46
	2017	5	927.89	0.001	38.473	98.81	83.76
	2018	5	110.29	0.001	36.249	96.33	27.28
	2019	5	244.88	0.001	65.203	99.09	109.92
	2020	5	107.77	0.001	53.579	97.65	42.52
	2021	11	1310.48	0.001	67.747	99.67	301.10
	2022	10	2203.27	0.001	335.484	99.61	254.52
	2023	9	193.67	0.001	21.315	96.72	30.45
	Overall	72	10140.77	0.001	139.783	99.72	360.90
Test of group differences: Q_b = chi2 (11) = 97.09 Prob > Q_b = 0.000							
By Study Setting	Both	34	7290.91	0.001	62.322	99.67	302.19
	IDPs	0	0	0.001	0	.	.
	Rural	16	408.24	0.001	53.963	95.32	21.36
	Semi-Urban	6	378.04	0.001	307.259	98.78	82.07
	Urban	11	839.05	0.001	259.520	99.41	169.87
	Overall	71	9712.76	0.001	118.551	99.68	310.19
Test of group differences: Q_b = chi2 (4) = 17.95 Prob > Q_b = 0.001							
By Study Season	Mixed	1	102.95	0.001	332.147	99.03	102.95
	Summer	9	960.03	0.001	90.539	98.08	51.96
	Autumn	15	503.93	0.001	37.466	95.44	21.95
	Spring	1	0.08	0.778	0	0	1.00
	Winter	8	263.54	0.001	71.124	97.22	35.97
	Overall	38	2844.81	0.001	64.263	97.81	45.58
Test of group differences: Q_b = chi2 (4) = 25.44 Prob > Q_b = 0.000							
By Study Design	Case-control	1	19.25	0.001	45.712	94.81	19.25
	Cross-sectional	66	8041.12	0.001	118.860	99.69	325.92
	Mixed method	1	171.01	0.001	876.842	99.42	171.01
	Prospective cohort	1	619.76	0.001	465.898	99.84	619.76
Test of group differences: Q_b = chi2(3) = 1.59 Prob > Q_b = 0.663							
By Sample Size	< 477	16	751.83	0.001	224.741	97.91	47.79
	477–704	20	830.81	0.001	139.655	98.06	51.54
	704–3464	16	1263.41	0.001	121.558	99.02	102.56
	> 3464	17	6786.94	0.001	60.474	99.82	561.70
	Overall	72	10140.77	0.001	139.783	99.72	360.90
Test of group differences: Q_b = chi2(3) = 6.12 Prob > Q_b = 0.106							
Total heterogeneity: Cochran's Q Test p-value = 0.001, I^2 = 99.3%							

Key: Both = Urban and rural, df = Degree of freedom, Mixed = > 1 Season, τ^2 = Between-study variance, I^2 (%) = Percentage of total variation across studies due to heterogeneity

this is that well-educated mothers are more likely to possess knowledge about proper sanitation, hygiene, and nutrition, which are crucial elements in preventing diarrhoeal infections [111]. Their ability to understand and implement preventive healthcare measures, such as timely vaccinations and appropriate child feeding practices, contributes to reducing the risk of diarrhoeal diseases. Furthermore, maternal education in child health highlights the importance of investing in educational opportunities for women as a comprehensive strategy to

Table 3 Synthesized findings on determinants of diarrhoeal diseases among under-five children in Africa (2013–2023)

Determinant category	Specific determinant	Effect on prevalence	Key findings	References
Socioeconomic Factors	Household Income	High income linked to lower prevalence	Studies consistently show a negative correlation between household income and the prevalence of diarrhoeal diseases.	[18, 19, 22–31]
	Maternal Education	Higher education associated with lower prevalence	Maternal education emerges as a protective factor against diarrhoeal diseases among under-five children.	[19, 24, 27, 29, 32–53]
	Maternal Age	Higher maternal age is associated with a decreased prevalence of diarrhea among children under five years old	Multiple studies revealed that younger maternal age is correlated with a higher prevalence of diarrhea among children under five years old	[20, 33, 35, 41–43, 50, 52–57]
	Paternal Occupation	Having occupation influence positively on diarrhoeal disease	Families with stable income enable better health services access to reduce diarrhoeal disease	[20, 45, 56, 58, 59]
	Children age	The highest prevalence of diarrhea is observed in infants, likely due to their vulnerable immune systems.	Diarrhea disease across children's age groups reveal that infants are highly vulnerable due to immature immune systems, toddlers face increased risk during weaning and exploratory behavior, while preschoolers experience reduced susceptibility with developing immune systems and improved hygiene practices.	[20, 25, 27, 29–31, 36, 40–42, 48, 54, 56, 60–65]
	Children sex	Biological, cultural, and societal factors influences to contribute to diarrhoeal diseases variations	Inconsistence findings were obtained.	[19, 33, 41, 42, 49, 56, 58, 66–68]
	Number of U5C	Larger number of children face higher prevalence of diarrhoeal diseases.	Increased risk due to difficulties in accessing proper sanitation and healthcare services.	[21, 24, 25, 35, 36, 38, 44, 58, 66, 69–71]
Behavioral Factor	Child stool disposal	Improper disposal contributes to transmission diarrhoeal disease.	Proper disposal essential to prevent fecal contamination of living Environment.	[25, 53, 66, 72–75]
	Hand washing practices at critical times	Effective hand washing reduces transmission etiologic agents of diarrhoeal disease.	Consistent hand hygiene at critical times in preventing diarrhoeal disease	[23, 24, 26, 31, 32, 49, 53, 60, 63, 65, 71, 72, 74, 76–86]
Environmental Factors	Sanitation Facilities	Improved sanitation lowers prevalence	Presence of improved sanitation facilities is a significant protective factor against diarrhoeal diseases.	[20, 34, 47, 50, 54, 72, 87–89]
	Drinking Water Source	Improved access reduces prevalence	Adequate access to clean water is consistently linked to lower rates of diarrhoeal diseases.	[23, 26, 34, 36, 38, 41, 47, 48, 51, 52, 54–56, 58, 60, 69, 72, 74, 80, 83, 86–99]
	Water Treatment	Inactivates pathogens, kills bacteria and viruses in water.	Water treatment at household level reduces waterborne diarrhoeal diseases.	[23, 34, 49, 52, 55, 57, 59, 67, 68, 74, 82, 90, 100, 101]
	Water Storage	Safe water storage essential for preventing waterborne infections.	Improper water storage increases the risk diarrhoeal disease.	[45, 49, 50, 82, 92, 102]
	Open Defecation	Open defecation contributes to disease spread	Open defecation is the cause for increasing diarrhoeal disease prevalence	[24, 34, 35, 38, 52, 58, 93, 103]
	Use shared Toilet	Shared toilets pose Environmental contamination	Diarrhoeal disease prevalence increased risk due to shared facilities.	[30, 59, 80, 100, 103]
	Solid waste management	Proper waste management reduces environmental health risks.	Inadequate disposal lead to diarrhoeal disease.	[24, 38, 39, 44, 50, 52, 59, 64, 74, 75, 87, 92–94, 104]
	Media exposure	Media can influence health behaviors including diarrhoeal disease prevention.	Educational campaigns can positively influence diarrhoeal disease.	[91, 105]
	Liquid waste management	Proper disposal prevents environmental contamination.	Effective liquid waste management reduces diarrhoeal disease risks.	[23, 25, 45, 53, 75]
	Improper food handling and consumption	Contaminated food contributes to infections.	Safe food handling and consumption practices are essential in preventing diarrhoeal diseases.	[31, 34, 61, 99]
Healthcare Access	Vaccination Coverage	Higher coverage lowers prevalence	Adequate vaccination coverage is associated with a decreased likelihood of diarrhoeal diseases.	[25, 28, 30, 49, 57, 61, 67, 82, 93, 98]

Table 3 (continued)

Determinant category	Specific determinant	Effect on prevalence	Key findings	References
Nutritional Factors	Exclusive Breastfeeding	Protective effect against prevalence	Exclusive breastfeeding emerges as a key protective factor against diarrhoeal diseases.	[20, 28, 38, 49, 53, 58, 61, 68, 71, 75, 76, 93]
Geographic variation	Central Africa, East Africa, North Africa, Southern Africa, West Africa,	There was significant variation (Test of group differences: Q_b = chi2 (4) = 43.36 Prob > Q_b = 0.001) in diarrhoeal diseases prevalence	Geographic difference of residence is associated with diarrhoeal diseases among under-five children.	[27, 30, 34, 40–43, 51, 52, 58, 59, 62, 68, 76, 88, 106, 107]
	Spatiotemporal variation		Varied prevalence across time and regions	[18, 41, 42, 96, 106, 108]

improve the well-being of children under the age of five in Africa [112].

From the findings of five studies, the prevalence of diarrhea disease in children under the age of five in Africa is influenced by maternal occupation [20, 45, 56, 58, 59]. Maternal jobs, often tied to socio-economic status, can impact household living conditions and resource accessibility [113]. This indicated, maternal employment is intertwined with factors such as education and healthcare access, further influencing the susceptibility of under-five children to diarrhoeal diseases [114].

The age of the mother or caregiver emerges as a crucial determinant affecting diarrhea prevalence in young children in Africa, as revealed by findings from 12 studies included in this systematic review [20, 33, 35, 41–43, 50, 52–57]. This variation could be explained by the unique challenges faced by younger mothers in childcare practices, potentially impacting hygiene routines and healthcare-seeking behavior [115]. Conversely, older caregivers may bring valuable experience but could encounter obstacles related to evolving childcare knowledge and changing health dynamics [116].

The evidence collected from 22 studies [20, 25, 27, 29–31, 36, 40–42, 48, 54, 56, 60–65] highlights that the age of children under five is a crucial determinant affecting the prevalence of diarrhea in Africa, showcasing distinct patterns across various age groups [117]. Infants, especially those in their first year of life, are particularly vulnerable due to their developing immune systems and reliance on breastfeeding or formula feeding [118], exposing them to potential contamination from water sources or inadequate hygiene practices. While toddlers and preschoolers exhibit a certain level of resilience compared to infants, their exploratory behaviors still render them susceptible to contaminated environments. Additionally, interconnected factors such as weaning practices, nutritional status, and access to clean water and sanitation services contribute to shaping the age-specific burden of diarrhea [117].

The impact of gender on the prevalence of diarrhea among children under five in Africa is influenced by a complex interplay of biological, cultural, and societal factors, as indicated by findings from 11 research studies [19, 33, 41, 42, 49, 56, 58, 66–68]. This might be due to differential care practices, nutritional disparities, and healthcare-seeking behavior may contribute to variations in diarrhea rates between boys and girls [119, 120]. Moreover, societal norms and cultural expectations could differently influence access to sanitation facilities, exposure to environmental contaminants, and overall hygiene practices based on gender. This finding supported by the study conducted in India [121].

The prevalence of diarrhoeal diseases among children under the age of five is influenced by the number of children. 12 research consistently indicates that households with a higher number of children under five tend to experience elevated rates of diarrhoeal infections [20, 25, 27, 29–31, 36, 40–42, 48, 54, 56, 60–65]. This correlation may be attributed to factors such as increased transmission opportunities within larger households, higher likelihood of shared exposure to contaminated environments, and potentially greater challenges in maintaining optimal hygiene practices. Additionally, the strain on resources in larger families, including difficulties in ensuring access to clean water, proper sanitation, and timely medical care, could contribute to the heightened susceptibility of children to diarrhoeal diseases.

Two studies conducted in Africa have explored the association between media exposure and the prevalence of diarrhea in this population [91, 105]. The findings suggest that higher media exposure, particularly to health-related information through various channels, is associated with a potential decrease in the prevalence of diarrhea. This might be access to educational programs, public health campaigns, and information about proper hygiene practices through media platforms may contribute to improved knowledge and awareness among caregivers, leading to better preventive measures against diarrhoeal diseases [122, 123].

Ensuring the adoption of optimal exclusive breastfeeding practices is essential in mitigating the prevalence of diarrhoeal diseases among children under five. This

assertion is substantiated by 12 studies conducted in Africa [20, 28, 38, 49, 53, 58, 61, 68, 71, 72, 88, 93]. The significance of this may stem from the fact that initiating breastfeeding within the first hour of birth and exclusively continuing it for the initial six months establishes a strong foundation for infants' immune systems [124]. This, in turn, provides protection against various infections, including those caused by diarrhoeal pathogens [125]. The immunological components present in breast milk, such as antibodies and enzymes, play a crucial role in preventing and alleviating the impact of diarrhoeal illnesses [126, 127].

Environmental factors exert effect on the prevalence of diarrhoeal diseases among children under five in Africa, carrying profound implications for public health [128]. The risk of diarrhoeal diseases among children under five is associated with unimproved toilet facilities and shared sanitation. Five studies revealed that the prevalence of diarrhea in children under the age of five in Africa is substantially impacted by insufficient access to proper toilet facilities and the prevalence of shared sanitation, highlighting these factors as critical contributors [30, 59, 80, 100, 103]. This can be attributed to the fact that, in many communities in developing countries, the absence of individual household toilets necessitates reliance on shared sanitation facilities, contributing to hygiene challenges and heightened disease transmission [129, 130]. Shared facilities often lack proper maintenance, increasing the risk of fecal-oral contamination. Furthermore, the proximity of these shared toilet facilities to households may vary, impacting convenience and utilization rates. Inadequate access to toilet facilities, coupled with reliance on shared sanitation, escalates the risk of diarrhoeal diseases among young children, exposing them to contaminated surfaces or water sources [131].

The findings from eight studies put forward that the high prevalence of diarrhea among children under the age of five in Africa is notably exacerbated by the widespread practice of open defecation [24, 34, 35, 38, 52, 58, 93, 103]. This is attributed to areas where inadequate sanitation is prevalent, open defecation becomes a common practice, leading to the contamination of water sources and the surrounding areas with fecal matter [132]. This combined impact of inadequate sanitation and open defecation presents a significant public health challenge, disproportionately affecting the under-five age group in Africa [133].

Based on findings from 35 studies, the choice of drinking water source has been identified as a determinant, with households relying on unimproved water sources experiencing higher disease prevalence [23, 26, 34, 36, 38, 41, 47, 48, 51, 52, 54–56, 58, 60, 69, 72, 74, 80, 83, 86–99]. This may be attributed to the microbial contamination of unimproved water sources by bacteria, viruses, and parasites, posing a significant health risk [134, 135]. Consequently, ingesting pathogens through contaminated water can lead to gastrointestinal infections.

Conversely, insights from 13 studies emphasize that implementing water treatment at the household level in Africa is a crucial strategy to mitigate the incidence of diarrhea among children under five [23, 34, 49, 52, 55, 59, 67, 68, 74, 82, 90, 100, 101]. The rationale behind this is that employing point-of-use at household level water treatment methods, such as boiling, chlorination, solar disinfection or filtration, could significantly reduce the microbial contamination of drinking water [136, 137]. Moreover, the integration of household water treatment aligns with broader efforts to improve water quality in resource-constrained settings where access to safe and clean water sources may be limited [138, 139].

A review of seven studies underscores the association between improper disposal of the youngest child's stools and an increased prevalence of diarrhea diseases [25, 53, 66, 72–75]. This may be attributed to unhygienic practices, such as inadequate disposal of diapers or a lack of access to child-friendly sanitation facilities, further contributing to the spread of pathogens [140, 141]. The consequences of these insufficient disposal practices are significant, elevating the risk of fecal-oral transmission and subsequent diarrhoeal infections among the vulnerable under-five Children.

Ineffective disposal practices of both liquid waste, as demonstrated by five studies [23, 25, 45, 53, 75], and solid waste, as evidenced by 16 studies [24, 38, 39, 44, 50, 52, 59, 64, 74, 75, 87, 92–94, 104], significantly contribute to the increased occurrence of diarrhea among children under the age of five. This may be due to insufficient sanitation, open defecation, and the pollution of water sources resulting from inadequate management of liquid and solid waste create environments that promote the transmission of diarrheal pathogens [142]. In addition, poorly handled solid waste, including actions like open dumping and burning, releases pollutants into the air and water, contaminating food and drinking water sources [143]. The sum of these unhygienic conditions significantly contribute to the prevalence of diarrhoeal diseases, posing a critical public health challenge for children under five in affected communities.

Based on findings from four studies, inadequate food handling and consumption practices emerge as noteworthy factors influencing the prevalence of diarrhoeal diseases among children under the age of four [31, 34, 61, 99]. This could be attributed to caregivers' insufficient hand washing, cross-contamination during food preparation, and the consumption of undercooked or contaminated foods, all of which contribute to the transmission of diarrhoeal pathogens [144]. Insufficient awareness regarding safe food handling practices, coupled with a

lack of access to clean water for food preparation, intensifies diarrhoeal problem [143].

Residence determinants encompass a variety of contextual factors that differ across countries, shaping disease patterns and affecting healthcare accessibility. As highlighted by 20 studies [27, 30, 34, 40–43, 51, 52, 58, 59, 62, 68, 76, 88, 106, 107], the urban-rural disparity in the factors influencing diarrhoeal diseases among children under the age of five in Africa between January 2013 and December 2023 underscores distinctive challenges and opportunities in these environments. This may be attributed to the fact that urban areas may enjoy enhanced access to sanitation infrastructure, healthcare services, and education, potentially leading to a reduction in the incidence of diarrhoeal diseases [122]. In contrast, rural areas often face constraints in accessing clean water sources, sanitation facilities, and healthcare, increasing vulnerability to diarrhoeal diseases.

The prevalence of diarrheal diseases among children under the age of five in Africa is closely linked to vaccination coverage. The consistent findings of nine studies suggest that increased vaccination coverage is strongly correlated with a significant decrease in the incidence of diarrheal diseases among this susceptible population [25, 28, 30, 49, 61, 67, 82, 93, 98].The possible explanation, immunizing vaccines that target specific pathogens, such as rotavirus and measles, play a crucial role in defending against severe diarrheal episodes, thereby reducing the risk of complications and potential fatalities [145].

According to eight studies, spatiotemporal variation in the occurrence of diarrheal diseases among under-five children in Africa reflects the dynamic interplay of geographic variation and temporal factors influencing disease patterns [18, 41, 42, 96, 106, 108]. The prevalence of diarrheal diseases varies across regions due to differences in environmental conditions, access to clean water, sanitation facilities, and healthcare infrastructure [146, 147]. Moreover, temporal variations of diarrhoeal disease may be attributed to seasonal changes, climate conditions impact water quality, hygiene practices, and disease transmission, leading to fluctuations in diarrhoeal diseases prevalence [148].

The first limitation of the review is publication bias not assessed. The second limitation is variations in study methodologies, and the reliance on available literature, which may not capture the full spectrum of determinants of diarrhoeal diseases among under-five children in Africa. Future research should prioritize longitudinal studies employing standardized methodologies, and explore emerging determinants, ultimately informing targeted interventions for reducing the burden of diarrhoeal diseases among under-five children in Africa. The third limitation is, since the majority of the included studies were conducted in Ethiopia, which may introduce bias due to the overrepresentation of studies from Ethiopia compared to others countries.

Conclusion

This systematic review provides a comprehensive understanding of the determinants of diarrhea diseases among children under the age of five in Africa between January 2013 and December 2023. The nuanced analysis of geographical variations, socioeconomic influences, environmental factors, and intervention outcomes underscores the complex nature of diarrhoeal disease. The findings highlight the necessity for region-specific and context-sensitive interventions to address the unique challenges faced by diverse communities. This review serves as a valuable resource for policymakers, healthcare professionals, and researchers, guiding the development of evidence-based strategies aimed at reducing the burden of diarrhea diseases and improving child health outcomes in Africa.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

Supplementary Material 5

Author contributions

Data curation: Jember Azanaw and Eshetu Abera Worede. Formal analysis: Jember Azanaw. Investigation: Jember Azanaw, Eshetu Abera Worede. Methodology: Jember Azanaw, Eshetu Abera Worede, Asmamaw Malede, and Hailemariam Feleke Yalew. Software: Jember Azanaw, Eshetu Abera Worede Validation: Jember Azanaw, Eshetu Abera Worede, WoredeAsmamaw Malede, and Hailemariam Feleke Yalew. Visualization: Jember Azanaw, Eshetu Abera Worede, Asmamaw Malede, and Hailemariam Feleke Yalew. Write-up – Jember Azanaw, Eshetu Abera Worede. Review & editing: Jember Azanaw, Eshetu Abera Worede, Hailemariam Feleke Yalew., and Asmamaw Malede.

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This research was done using a publicly available dataset found at published works.

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Consent for publication

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There was no direct involvement of patients or public.

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The authors declare no competing interests.

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