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Prevalence of Undernutrition Among Children and Adolescents with Cancer Living in Sub-Saharan African Countries: A Systematic Review and Meta-analysis

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Abstract

Objective. To systematically review studies to provide the pooled estimate of undernutrition among children and adolescents with cancer living in sub-Saharan African countries. *Methods*. The review followed the recommendations outlined in the PRISMA statement. Online searches were performed on electronic databases such as PubMed, Scopus, Embase, and Hinari; gray literature sources: such as Google, Google Scholar, and university repositories were also searched. A random effect model was used to drive the pooled prevalence, and was reported at a 95% Confidence Interval (CI). Heterogeneity was assessed using subgroup analysis and univariable meta-regression. The effect of each study on the overall prevalence was assessed using leave-one-out sensitivity analysis. In all the models, statistical significance was set at *P*-value $<$.05. *Result*. A total of 623 articles were identified, and 21 articles were retrieved for the final analysis. The overall pooled prevalence of undernutrition was 41.34% (95% CI: 31.64%, 51.04%). The highest prevalence of undernutrition was observed from studies that used Arm Muscle Area (AMC) for age to assess undernutrition: 61.66% (95% CI: 47.59%, 75.72%). The protocol for this review has been registered at PROSPERO (CRD42024510052). *Conclusion*. The prevalence of undernutrition in sub-Saharan African countries was considerably high. Therefore, policy directions and cost-effective approaches that sustainably address undernutrition among pediatric patients with cancers are needed.

Keywords

undernutrition, cancer, children, adolescents, and sub-Saharan Africa

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Introduction

Diet-related noncommunicable diseases (NCDs), such as cancer, are rising in sub-Saharan Africa (SSA).[1] In recent years, the increasing prevalence of cancer among children and adolescents in low- and middle-income countries (LMICs) has attracted global attention. According to the World Health Organization (WHO) almost 400 000 children and adolescents are diagnosed with cancer each year. Most of these cases are from low- and middle-income countries (LMICs).[2]

The cure rate for childhood cancer in industrialized nations is high; however, the actual cure rate for childhood cancer in resource limited areas is far below the 2018 WHO projection.[3] For example, the overall 5-year survival rate in high-income countries (HICs) reaches as high as 90%,[4] whereas the childhood cancer survival rate in Africa is approximately 20%.[5]

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This owes to the challenges that healthcare providers face in providing optimal care for cancer therapy.[6] These might range from low socio-economic background, higher rates of comorbidities, to extreme forms of malnutrition.[6,7] Malnutrition in children with cancer increases the risk of complications and abandonment of treatment, which in turn negatively affects their survival.[8,9] The consequences of undernutrition among children with cancer are multifaceted.[8,10] On top of the debilitating effect of the disease, quality of life and clinical outcomes were unfavorable among undernourished pediatric patients with cancer.[11] In addition, treatment costs were observed to be higher among malnourished pediatric oncology patients.[12]

Therefore, in recent years, assessing the nutritional status of children and adolescents with cancer has become the focus of different cancer related studies.[13] These studies have revealed that, in a clinical situation, a small change in weight has a significant effect on the overall prognosis of the disease.[8,13,14]

In resource-limited countries, the proportion of undernutrition among young children and adolescents is more pronounced.[15] However, the accent is silent when it comes to undernutrition that is associated with NCDs, including cancer. Since the end of the first decade of the 21st century, however, reports on malnutrition among the pediatric oncology population have started to emerge.[16,17]

Despite different reports released from different corners of SSA countries, to the best of our knowledge, there is no pooled estimate on the magnitude of undernutrition among children and adolescents with cancer living in SSA countries. In a region where resources are overstretched, identifying the magnitude of undernutrition in a highly vulnerable group is pivotal in supporting evidence-based policy, rational planning, resource allocation, and designing appropriate interventions that aimed at curving the overlooked issue among children and adolescents with cancer.

Methods and Materials

This Systematic Review and Meta-analysis (SRMA) was prepared adhering to recommendations outlined in PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (S1-PRISMA _2020.docx). The protocol of this review was registered at PROSPERO on 17th of February, 2024 (Registration ID: CRD42024510052).

Databases and Search Terms

A comprehensive search of original articles published in in English was done from January 2024 to March 2024, with no restriction on publication year. A thorough search of electronic databases such as Pub med, Embase, Scopus and Hinari (Research4life) was conducted using the following search terms: (Cancer OR (Benign AND Neoplasm) OR (Benign AND Neoplasms) OR (Malignanc*) OR (Malignant AND Neoplasm) OR (Malignant AND Neoplasms) OR Neoplasia OR Neoplasms OR (Neoplasms AND Benign) OR (Tumor*) OR Tumors) AND (Malnutrition OR (Malnourishment*) OR (nutrition* AND deficienc*) OR undernutrition OR leanness OR underweight OR (Severe AND Acute AND Malnutrition)) AND ((Adolescent) OR (Adolescence*) OR Adolescents OR[14] OR (Teenager*) OR Teens OR (Youth*) OR (Youngster*) OR Children OR[14] OR (Pediatric*)). The names of the sub-Saharan Africa (SSA) countries were also combined with the above terms, and each African countries were combined using the Boolean operators like "AND" and OR.

Gray literature sources like Google, Google Scholar, and university repositories were also searched to identify relevant articles for the review. Finally, reference lists of the included articles were searched (Snowball technique) to identify additional studies that might have been missed through the online searches. The identified articles (623 articles) through the above searches were uploaded to Rayyan (https://rayyan.ai/reviews/950676)-AI powered tool for systematic review and meta-analysis screening. After removing 145 duplicates, 478 articles were identified. Two reviewers (BM and MCA) independently screened the titles and abstracts of the remaining articles according to eligibility criteria. Similarly, the same authors screened full-text articles for eligibility. When there were discrepancies between the 2 reviewers, a third author (LDB) was invited to resolve the issues (S2-search strategy .docx).

Eligibility Criteria

We have used the CoCoPop (Condition, Context, and Population) approach to prevalence studies to include and exclude identified articles.

Inclusion and Exclusion Criteria

Observational studies published in English that reported undernutrition among children and adolescents (10-19 years) with cancer residing in at least one of the SSA countries were included. However, experimental studies, qualitative studies, reviews, and commentaries were excluded. Studies that reported undernutrition among children and adolescents with cancer living outside of SSA countries were also excluded.

We included articles that defined undernutrition in at least one of the following outcomes: Body Mass Index (BMI) for age below −2SD, weight for height below −2SD, and Arm Muscle Area (AMA) below the fifth percentile.

Data Extraction and Quality Assessment

Two authors (BM and MCA) independently extracted data from the included studies, and disagreements on data extraction were resolved in the presence of the review team. Name of the author, year of publication, study period, study setting, country of the original studies, study design, publication type, mean age of the participants, type of cancer, outcome measurement, sample size, and number of participants with outcome (prevalence rate of undernutrition) were extracted using a customized form created on Microsoft Excel.

Two authors (BM and MCA) objectively assessed the quality of the eligible studies using Newcastle Ottawa (NCO) Scale for cross-sectional studies,[18] disagreements were resolved by the direct involvement of the third author (LDB) in evidence-based discussions. An overall score ≥ 6 was used to define the quality of the studies as moderate and high quality (S3-Data Extraction Form.xlsx).

Statistical Analysis

Statistical and meta-analysis for proportion was carried out using STATA software version 17. The final result was presented as pooled prevalence in 95% Confidence Interval (CI). As there was significant heterogeneity, the pooled prevalence of undernutrition was presented using random effect model with DerSimonian-Laird weighing. Fixed effect model was done for comparison. Cochrane Q-test and I^2 statistics was used to detect heterogeneity, as such 25%, 50%, and 75% I^2 values were used as cut off points for mild, moderate and significant heterogeneity, respectively.[19,20] Possible causes of heterogeneity were investigated using subgroup analysis with reference to publication year, African Regions, type of centers, type of study setting, type of publication, and primary focus of the study. These findings were presented graphically using a forest plot. To determine the effect of each study on the overall pooled effect, leave-one-out sensitivity analysis was performed. Univariable meta-regression was also performed using publication year, sample size, study area, and mean age of the respondents of the primary studies. Publication bias was assessed visually using a funnel plot, and statistically using Egger's regression test. In all the analysis, statistical significance was declared at P-value $< .05$.

Results

Search Results

Of the 623 articles identified, 145 articles were excluded due to duplication. By looking at the titles and the abstracts of the remaining articles, 411 articles were excluded-making 67 articles candidates for full-text search. Out of this, 28 were assessed for eligibility. Finally, 21 articles were included in the final review, of these studies the majority (16 studies) were from peer reviewed journals (Figure 1).[21-36]

Characteristics of the Identified Articles

The studies were conducted in 8 African countries; most of the studies were from Southern Africa countries: thirteen studies were from South Africa and Malawi.[25-29,31-34,37-40] All but 6 of the included studies were conducted at a single institution. In 13 of the included studies, undernutrition was the primary focus of the study,[23-25,27,29-31,34,35,37,40-42] while in the remaining 8 it was not the primary focus of the study.

In the review, a total of 3132 children and adolescents with cancer were included. In this analysis, 18 studies reported the mean age or median age of the participants in years; accordingly, the minimum mean age (3.67 years) was reported by Trijn Israëls et al,[26] and the maximum was reported by Ellis et al[28] (10 years). Moreover, in the studies, minimum and maximum age of the participants were documented in 17 of the studies. In these studies, the minimum age of the participants was 3 months, and the maximum age was 18 years (Table 1).

In the majority of the studies, children with different kinds of cancer were included. However, 5 of the studies focused on one type of cancer; 3 of these studies reported undernutrition among children with Wilms tumor, and the remaining were reported among children with lymphomas. In the majority of the studies (19 studies) used either BMI for age or weight for height to define undernutrition, while the remaining used Arm Muscle Area (AMA) for age to define undernutrition. Moreover, in the majority of the included studies nutritional status of the participants was assessed before the commencement of treatment (19 studies) (Table 1).

Prevalence of Undernutrition Among Children and Adolescents with Cancer

In the fixed effect model, there was a significant heterogeneity. Therefore, we performed a random effect model by applying Dersimonian and Laird weighing. Accordingly, two-fifth [41.34% (95% CI: 31.64, 51.04)] of children and adolescents with cancer living in SSA countries were undernourished with significant heterogeneity ($I^2 = 97.75\%$, $P = .00$). In this review, the highest weight was attributed to Beringer et al[33] and the lowest was attributed to Israëls et al[25] (Figure 2).

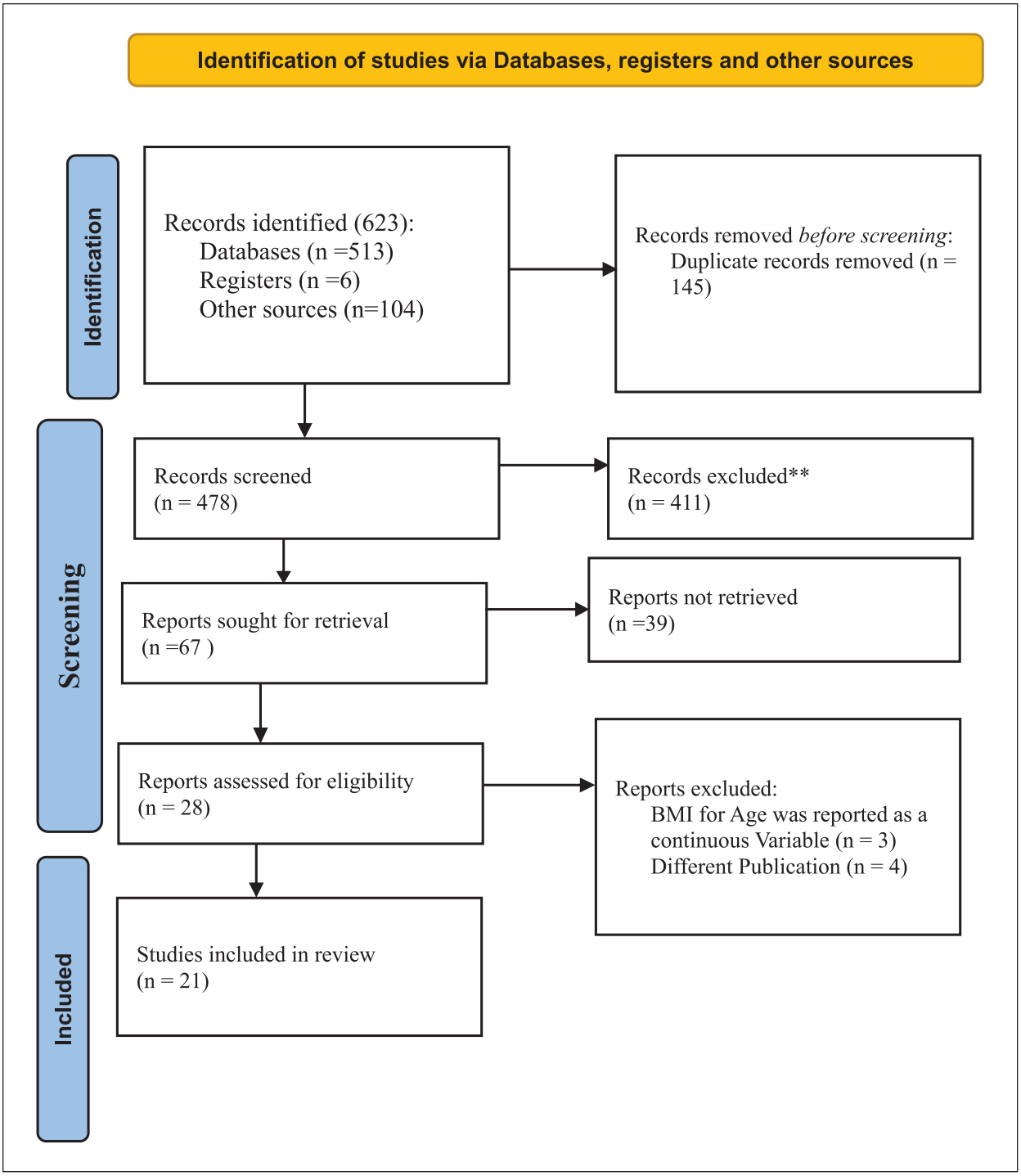

Figure 1. PRISMA flow chart of the systematic review.

Heterogeneity Assessment Using Subgroup Analysis

To further investigate potential sources of heterogeneity, subgroup analysis was performed by publication year, African Regions (country of origin), type of centers, type of study setting, type of publication, and primary focus of the study; however, heterogeneity was not controlled. Nevertheless, the subgroup analysis by African regions showed that the highest prevalence was seen in studies

Table 1. Characteristics of the Included Studies (N = 3132).

Author	Publication year	Country	Publication type	Type of cancer	Undernutrition as primary focus of the study	Type of tool	Sample size	Mean age (years)	Nutritional assessment	Prevalence with 95% CI
Tola et al[21]	2023	Ethiopia	Peer reviewed	All	No	W for H	73	7.82	Before treatment	27.39 (17.17, 37.63)
Yifru and Muluye[22]	2015	Ethiopia	Peer reviewed	All	No	W for H	71	7	Before treatment	67.61 (56.72, 78.49)
Apprey et al[23]	2018	Ghana	Peer reviewed	All	Yes	BAZ	64	NA	Before treatment	39.06 (27.11, 51.02)
Salifu et al[24]	2022	Ghana	Peer reviewed	All	Yes	BAZ	130	4.5	Before treatment	22.31 (15.15, 29.46)
Okemwa Julian Nyaboke,[41]	2017	Kenya	Not peer-reviewed	All	Yes	W for H	52	NA	After commencement of treatment	55.77 (42.27, 69.27)
Israëls et al[25]	2009	Malawi	Peer reviewed	Wilms tumor	Yes	W for H	20	3.67	Before treatment	45.00 (23.19, 66.80)
Trijn Israëls et al[26]	2008	Malawi	Peer reviewed	Burkitt's Lymphoma	Yes	AMC for age	84	7.2	Before treatment	69.05 (59.16, 78.93)
Israëls et al[27]	2008	Malawi	Peer reviewed	All	Yes	AMC for Age	128	7	Before treatment	54.69 (46.06, 63.31)
Holmes et al[38]	2022	Malawi	Not peer-reviewed	Wilms tumor	No	W for H	136	3.8	Before treatment	41.18 (32.90, 49.45)
Ellis et al[28]	2021	Malawi	Peer reviewed	Lymphomas	No	W for H	74	10	Before treatment	72.97 (62.85, 83.09)
Huibers et al[29]	2022	Malawi	Peer reviewed	All	Yes	W for H	463	6	Before treatment	63.07 (58.67, 67.46)
Chukwu et al[30]	2016	Nigeria	Peer reviewed	All	Yes	BAZ	104	7.7	Before treatment	9.61 (3.45, 15.28)
Schoeman et al[31]	2023	South Africa	Peer reviewed	All	Yes	BAZ	320	5.3	Before treatment	11.56 (8.06, 15.16)
Schoeman et al[32]	2023	South Africa	Peer reviewed	All	No	BAZ	261	6.3	Before treatment	11.88 (7.95, 15.80)
Kelly Sue Draper[39]	2016	South Africa	Not peer-reviewed	Wilms tumor	No	BAZ	76	4.58	Before treatment	30.26 (19.93, 40.59)
Lifson[40]	2017	South Africa	Not peer-reviewed	Wilms tumor	Yes	BAZ	62	4.67	Before treatment	66.13 (54.35, 77.91)
Geddara et al[34]	2023	South Africa	Peer reviewed	All	Yes	BAZ	139	4.33	Before treatment	31.66 (23.92, 39.39)
Beringer et al[33]	2021	South Africa	Peer reviewed	All	No	BAZ	602	5.38	Before treatment	14.62 (11.79, 17.44)
Monko et al[35]	2024	Tanzania	Peer reviewed	All	Yes	W for H	131	NA	Before treatment	22.14 (15.03, 29.25)
Abdoulie Ceesay[42]	2022	Tanzania and Uganda	Not peer-reviewed	All	Yes	W for H	77	5.42	Before treatment	59.74 (48.79, 70.69)
Yadurshini Raveendran et al[36]	2020	Tanzania	Peer-reviewed	All	No	W for H	65	5.56	After commencement of treatment	60.00 (48.09, 71.91

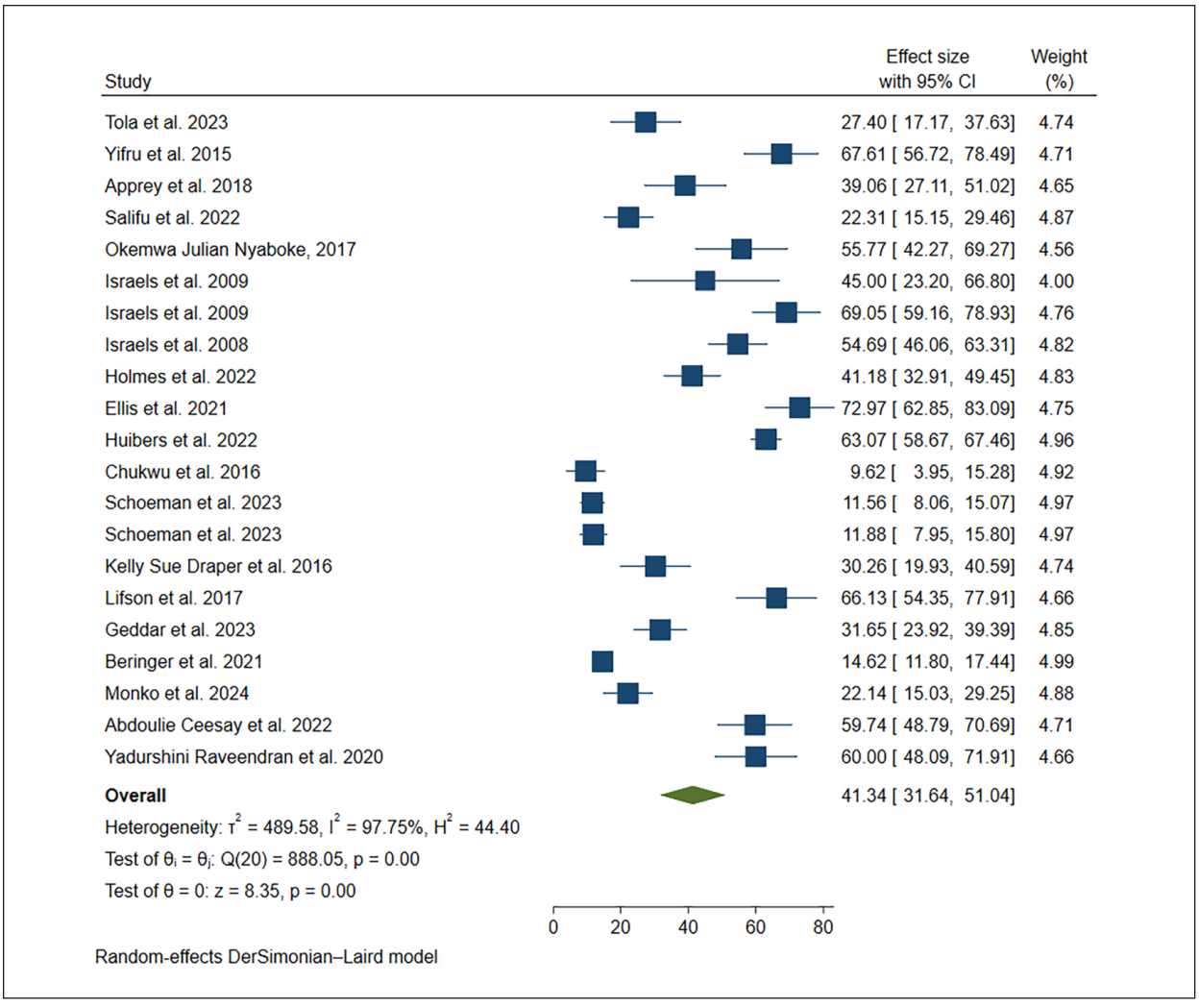

Figure 2. Forest plot of studies evaluating the magnitude of undernutrition among children and adolescents with cancer.

that were from Eastern African countries [48.50% (95% CI: 31.35, 65.66) I^2=93.89%, P=.00] (Figure 3).

The subgroup analysis by the number of centers included has shown studies conducted at a single cancer treatment center reported a relatively higher proportion of undernutrition [47.10% (95% CI: 36.07, 58.12) I^2=96.05%, P=.00] (Figure 4). With regard to publication type, studies retrieved from non-peer reviewed sources (thesis and dissertations) have shown relatively higher proportion of undernutrition [50.28% (95% CI: 37.41, 63.16) I^2=86.07%, P=.00] (Figure 5). Studies whose primary focus the study was on undernutrition have revealed relatively higher proportion of undernutrition [42.02% (95% CI: 28.35, 55.69) I^2=97.81%, P=.00] (Figure 6).

As to type of tool used to assess undernutrition, a higher proportion of undernutrition [61.66% (95% CI: 47.59, 75.72) I^2=78.27%, P=.03] was seen from studies that used Arm Muscle Circumference (AMC) for age (Figure 7). Finally, studies that reported undernutrition among children and adolescents with one kind of cancer—study population that comprised one kind of cancer showed relatively higher proportion of undernutrition [54.35% (95% CI: 39.31, 69.40) I^2=91.17%, P=.00] (Figure 8).

Meta-regression

Meta-regression is an extension of subgroup analysis that can be used to assess the effect of moderators on the outcome variable. The meta-regression revealed that the prevalence of undernutrition significantly varies depending on the number of centers included; either multi-center or single-center [β=23.67 (95% CI: 6.51, 40.81 with R^2=43.47]. However, the prevalence of undernutrition was not considerably varied based on publication year, African regions, publication type, primary focus of the

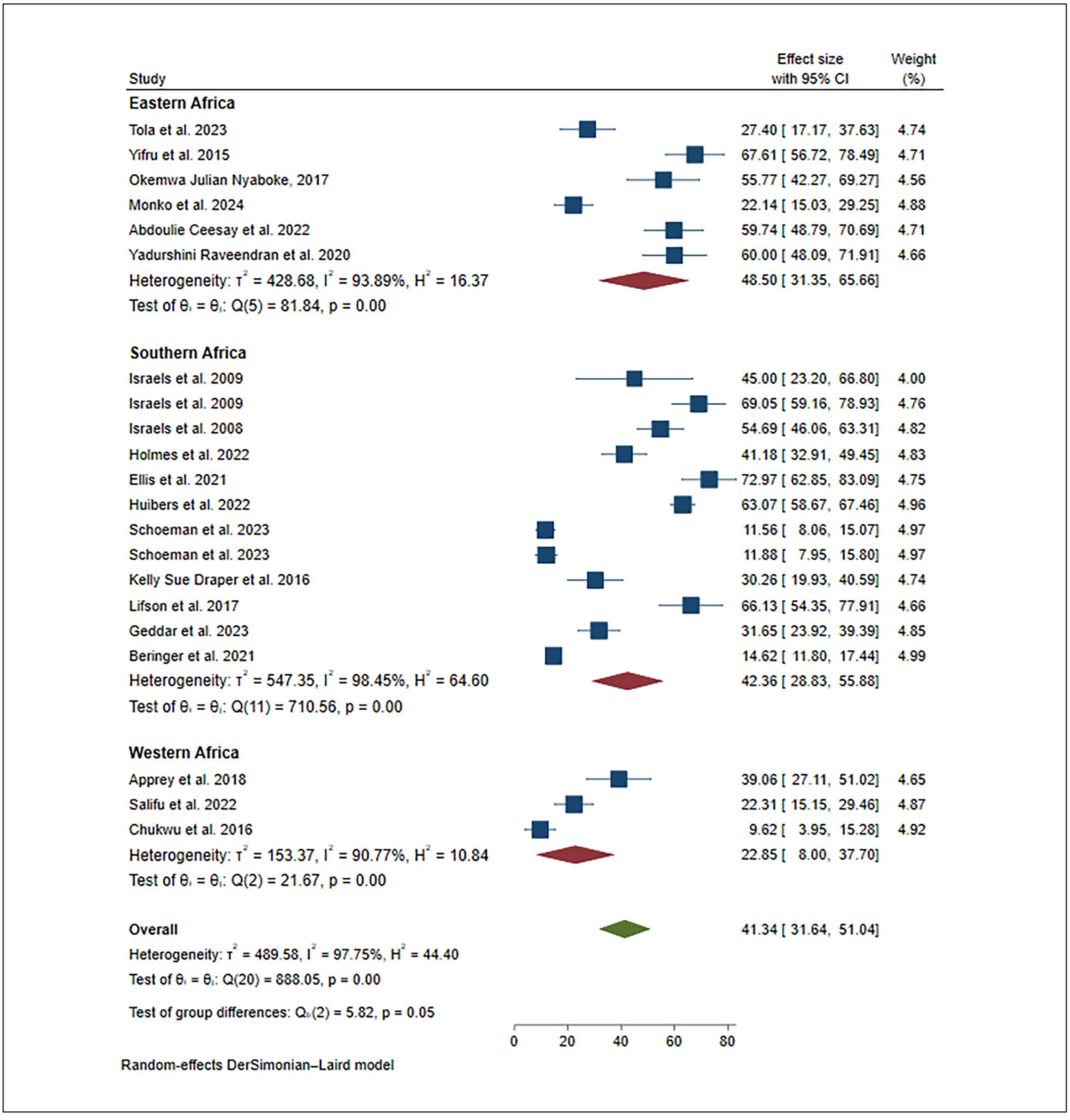

Figure 3. Forest plot of studies evaluating the magnitude of undernutrition among children and adolescents with cancer subgroup analysis by Africa Region.

study, type of tool used, and type of cancer included (Table 2).

Sensitivity Analysis

Sensitivity analysis revealed that in the random effect model, no single study influenced the pooled prevalence of undernutrition. The result showed that the omitted studies did not show a significant difference in the prevalence of undernutrition among children and adolescents with cancer living in SSA countries (Figure 9).

Publication Bias

Funnel plot and Egger's test were used to visually and statistically assess publication bias, respectively. Accordingly, significant publication bias was observed (Coefficient = 5.49, $P < .05$). Besides, after fitting each

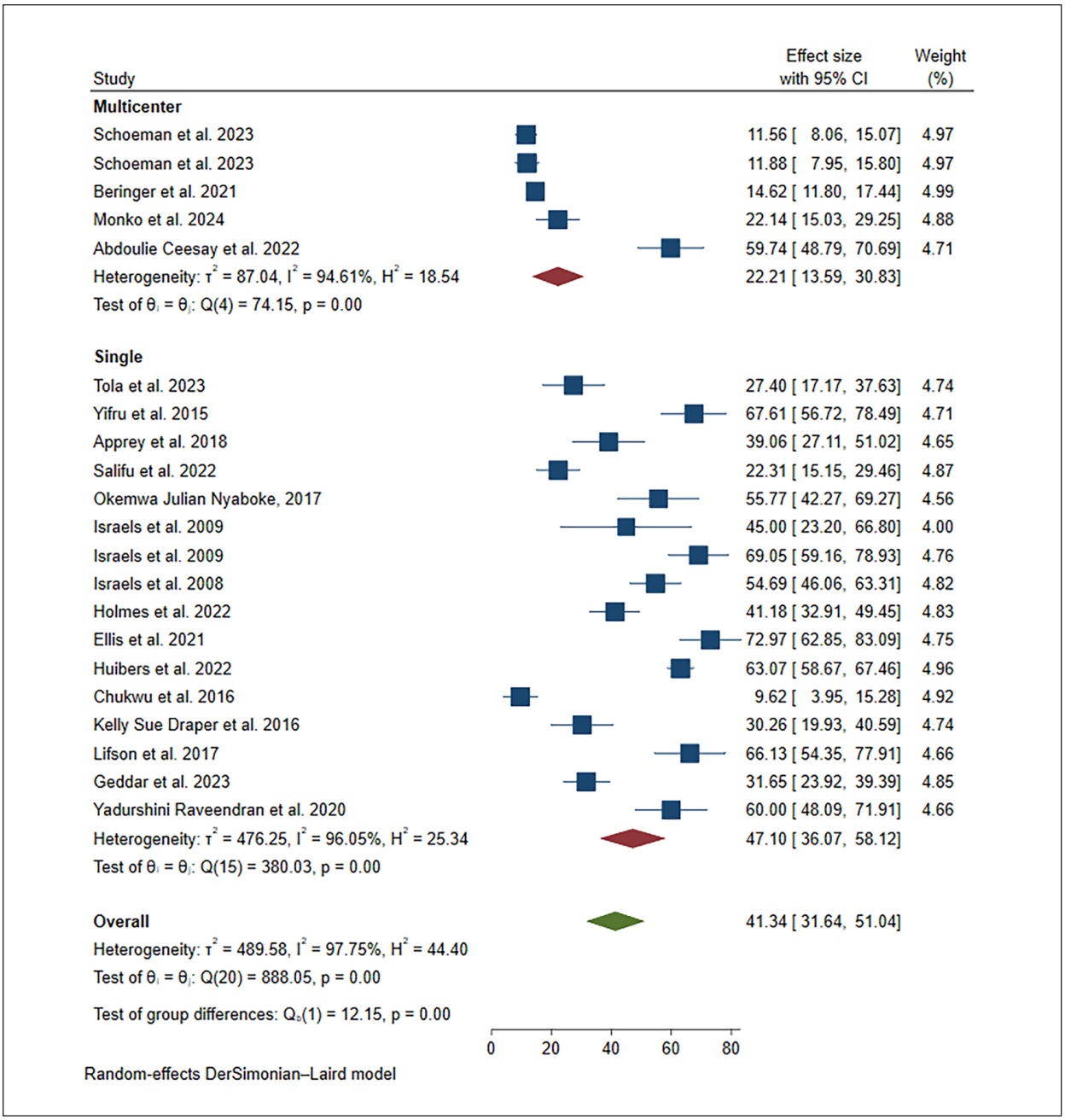

Figure 4. Forest plot of studies evaluating the magnitude of undernutrition among children and adolescents with cancer subgroup analysis by number of centers included.

covariate that were considered in the meta-regression, small study effect was also observed (Figure 10). Therefore, to handle the small study effect trim and fill analysis was performed. Thus, after adding 10 imputed missing studies, the overall pooled estimate of undernutrition among children and adolescents with cancer in SSA was 19.21% (95% CI: 8.28, 30.15 with $P = .00$) (Figure 11).

Discussion

The current systematic review and meta-analysis reported the magnitude of undernutrition among children and adolescents with cancer living in SSA. In the review, 21 primary studies that reported undernutrition among children and adolescents with cancer were identified. The studies were retrieved from databases and

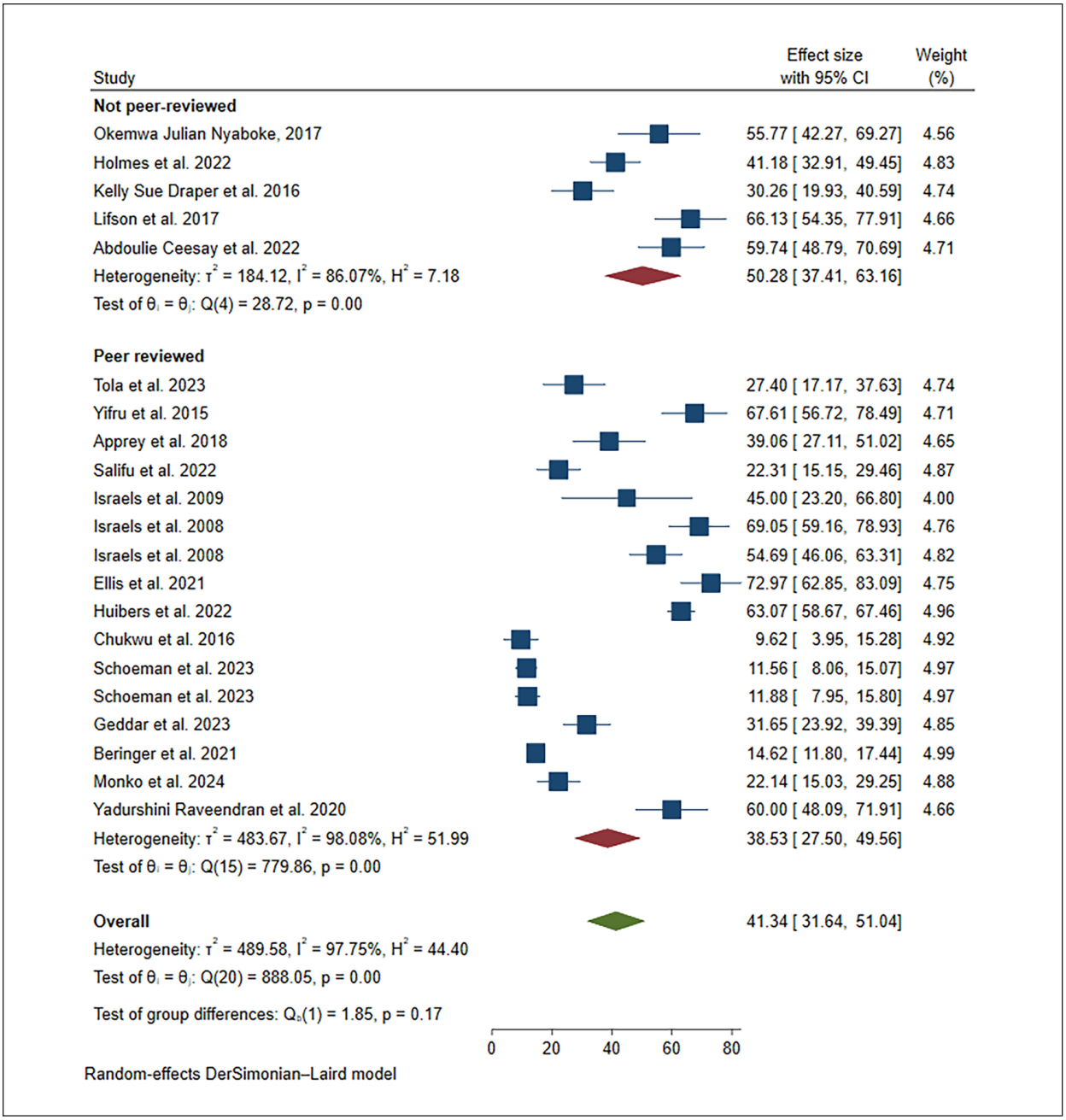

Figure 5. Forest plot of studies evaluating the magnitude of undernutrition among children and adolescents with cancer subgroup analysis by publication type.

gray literature sources, and were published between 2008 and 2024. Despite the unrestricted search for publication year, we were not able to find articles that were published before 2008-indicating the dearth of cancer related researches in Africa in the early 21st century and before.

Most of the retrieved studies were from southern Africa countries (13 studies), followed by studies from eastern Africa countries (5 studies)[21,22,36,41,42] and western Africa countries (3 studies).[23,24,30] However, we did not find a study that reported undernutrition among children and adolescents in Central African countries.

The meta-analysis revealed that almost two-fifth of children and adolescents with cancer were undernourished [41.34% (95% CI: 31.64, 51.04) (I^2=97.75%, P=.00)]. This highlights the issue of undernutrition, and

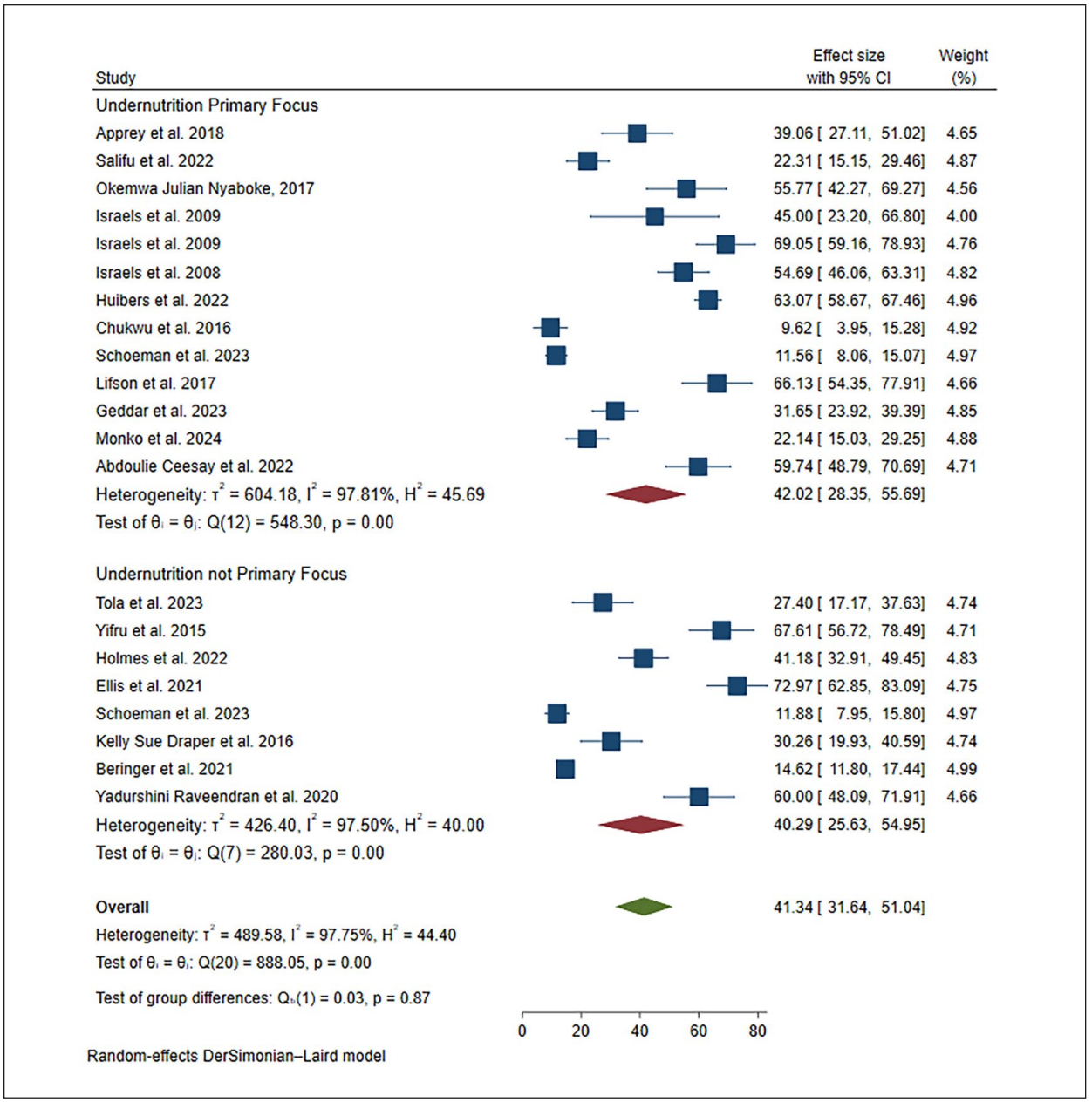

Figure 6. Forest plot of studies evaluating the magnitude of undernutrition among children and adolescents with cancer subgroup analysis by focus of the study.

nutritional care for children and adolescents with terminal illnesses are not receiving sufficient attention in Africa.[43] More to this, the current SRMA showed that the magnitude [48.50% (95% CI: 31.35%, 65.66%)] of undernutrition was more pronounced among children and adolescents with cancer from Eastern Africa countries, implying that LMICs still bear the greatest burden of undernutrition, even in clinical settings. Undernutrition was pervasive among children diagnosed with cancer who were from low-and middle-income nations.[25] Despite the substantial reduction in the magnitude of undernutrition among children and adolescents in the general population,[44] the issue has not been touched or overlooked among pediatric patients with cancer.[45]

Overall, the pooled prevalence of undernutrition in the current study was higher than previous literature reviews from Brazil, the SRMA reported that the magnitude of underweight varied from 6% to 25%.[46] Primary

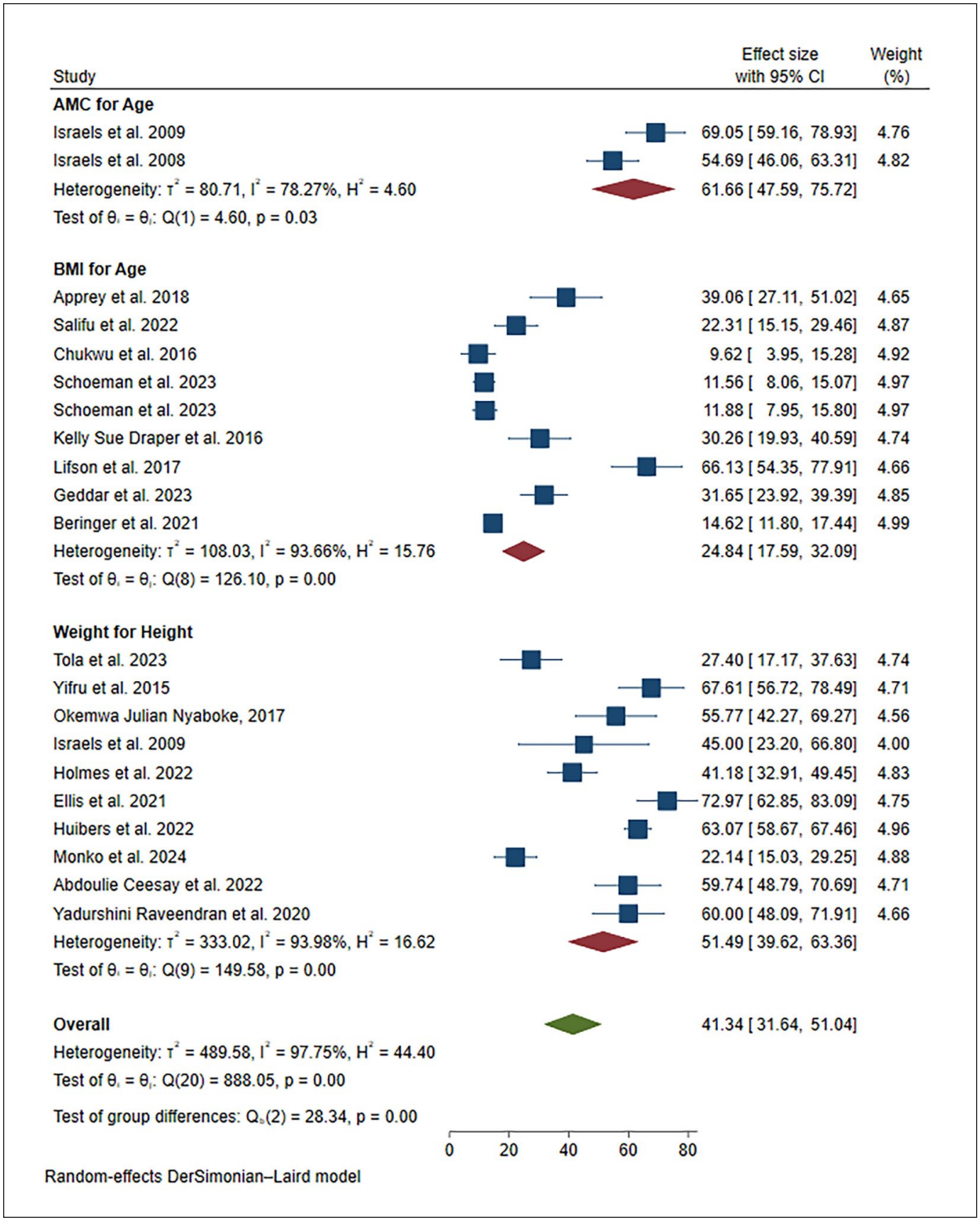

Figure 7. Forest plot of studies evaluating the magnitude of undernutrition among children and adolescents with cancer subgroup analysis by type of tool used.

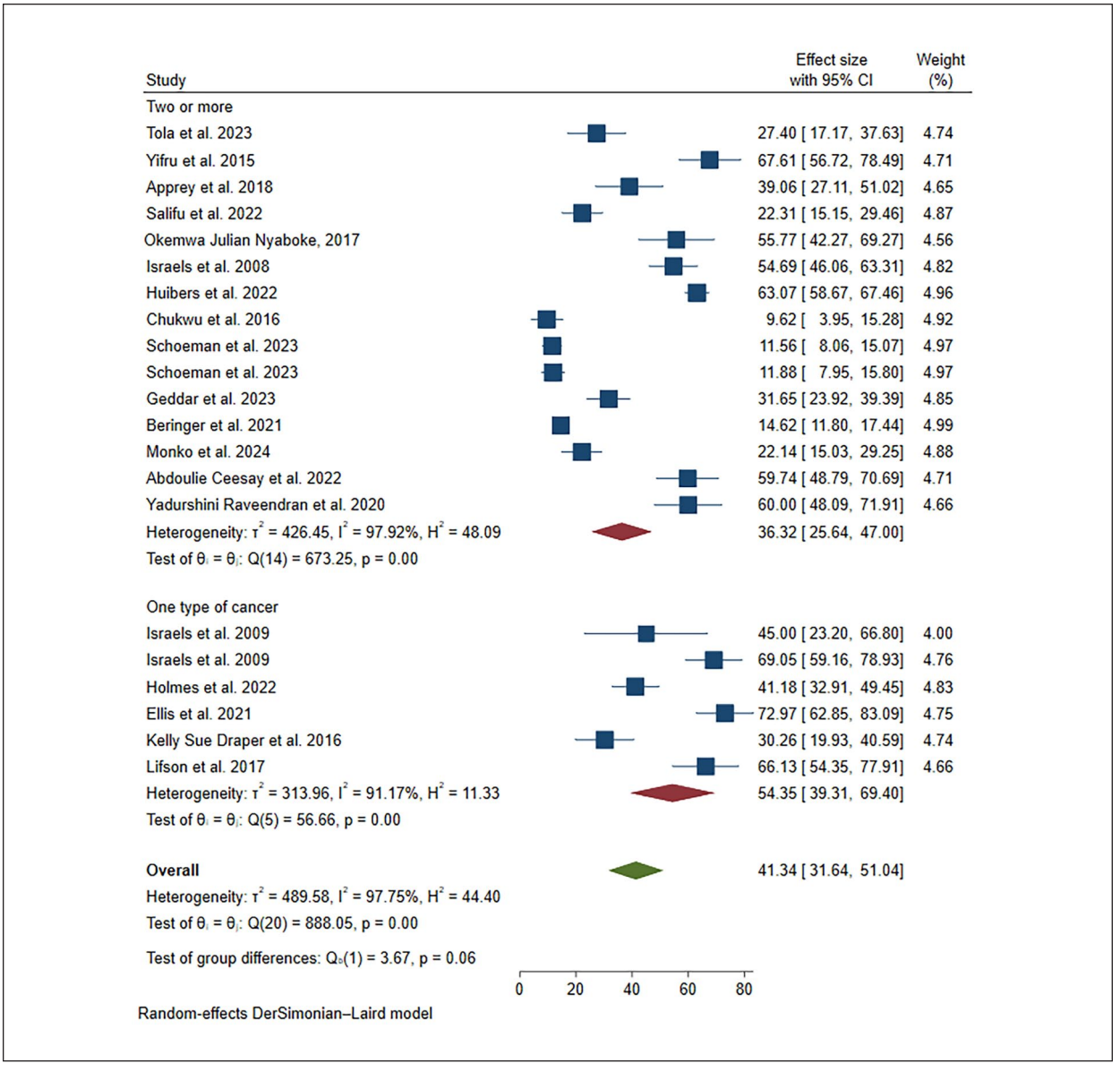

Figure 8. Forest plot of studies evaluating the magnitude of undernutrition among children and adolescents with cancer subgroup analysis by number of cancer cases included.

Table 2. Univariable Meta-regression for Prevalence of Undernutrition Among Children and Adolescents with Cancer in Sub-Saharan African Countries, 2024.

Moderator	Coefficient (95% CI)	SE	Adjusted R^2 (%)	*P*-value
Publication year	0.014 (−0.01, 0.37)	0.01	5.38	.20
Africa region	−11.35 (−26.22, 3.53)	7.59	4.26	.13
Number of centers included	23.67 (6.51, 40.81)	8.7	43.47	.00
Publication type	−11.96 (−34.19, 10.26)	11.34	6.00	.29
Primary focus of the study (yes/no)	−1.61 (−22.33, 19.11)	10.57	0.00	.59
Type of tool	6.58 (−7.08, 20.25)	6.97	16.55	.34
Type of cancer	17.99 (−2.08, 38.08)	10.25	15.10	.08

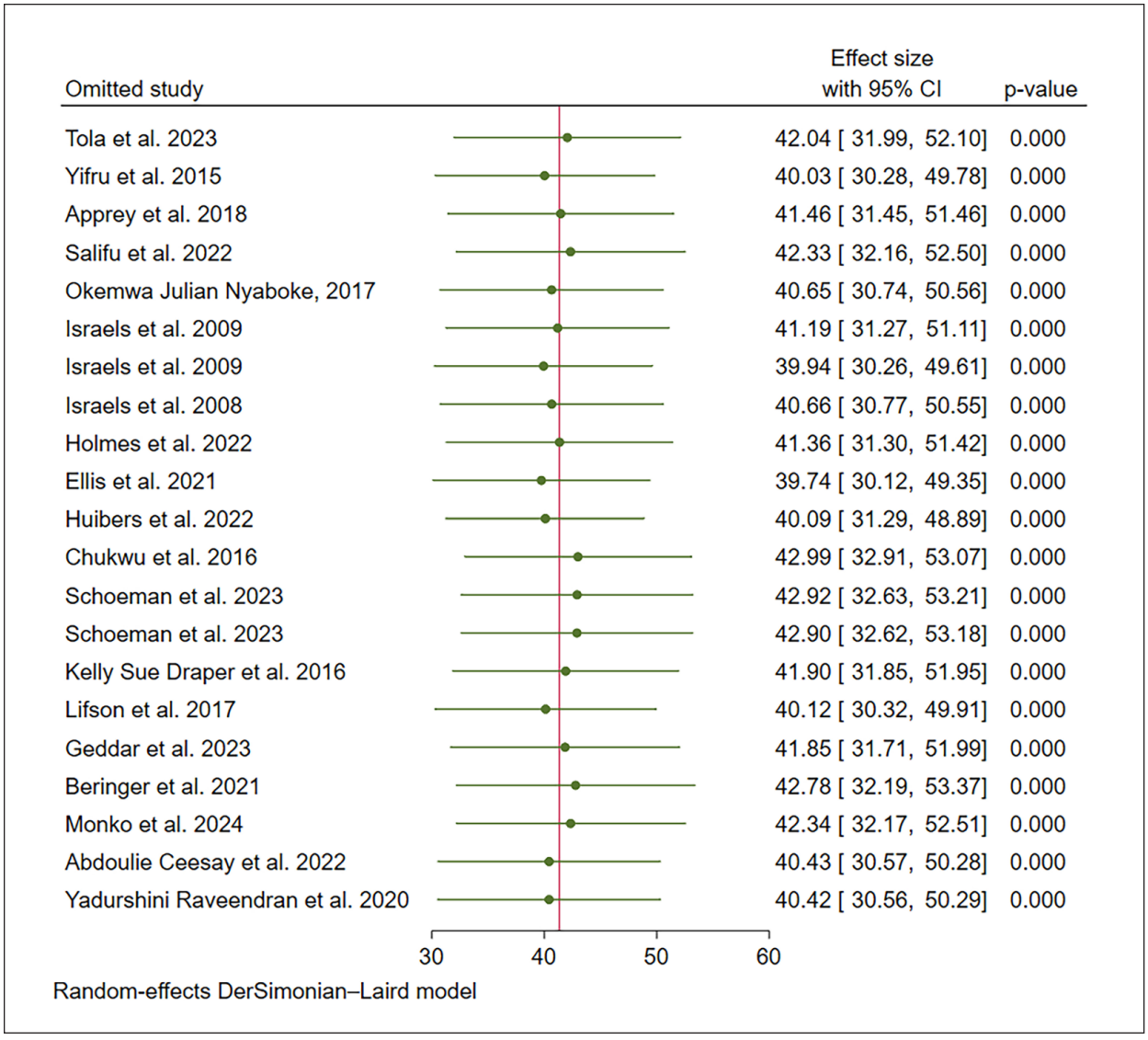

Figure 9. Leave one out sensitivity analysis.

studies from HICs have also revealed smaller magnitude of undernutrition among children with cancer.[47,48]

Researchers from high-income countries (HICs) have communicated that appropriate nutritional care aimed at alleviating the issues of undernutrition has brought positive outcome even for those with terminal illness.[49] Poor quality of life and mortality from cancer among children and adolescents residing resource limited areas like Africa might be explained by the increased magnitude of undernutrition.[50] Similarly, studies from HICs have reported that undernutrition strongly influences outcomes and prognosis of pediatric patients with cancer.[48]

When we delve into the magnitude of undernutrition regionally- WHO Africa region, the proportion of undernutrition among pediatric patients with cancer from western Africa countries was considerably lower [22.85% (95% CI: 8.00, 37.70)] than the pooled report from other SSA regions. Recent economic booms, a robust healthcare system, and policy equity to avert or deter emerging NCDs, especially in Nigeria and Ghana could explain these trends.[51]

However, the situation in southern Africa varies significantly between countries. In Malawi, for instance, higher rates of undernutrition among pediatric cancer patients highlight the challenges faced by the healthcare system, including resource constraints and limited access to comprehensive nutritional support.[52] In contrast, South Africa's lower reported rates of undernutrition reflect a more developed healthcare system and

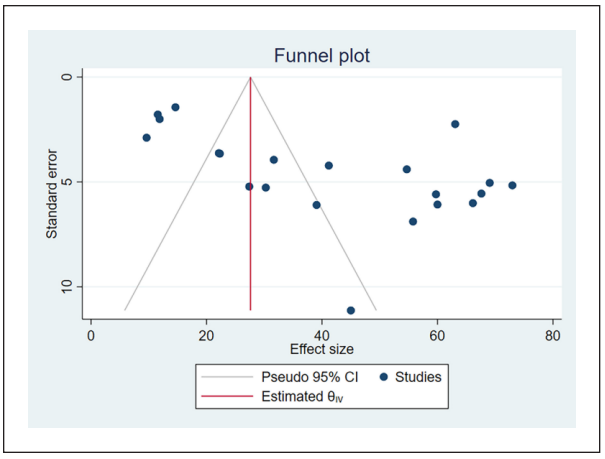

Figure 10. Funnel plot publication bias.

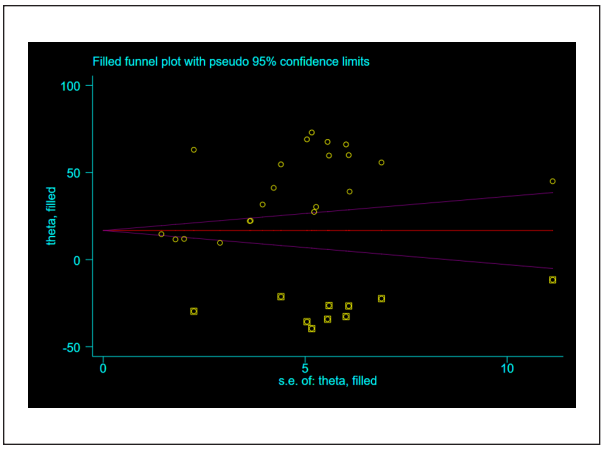

Figure 11. Trim and fill analysis.

better access to healthcare services, although disparities within the country still exist.[53]

Differences in the magnitude of undernutrition was observed in terms treatment centers included in the studies as well. Even with significant heterogeneity, there was a visible discrepancy in the magnitude of undernutrition between studies that involved only one center (47.10%: 36.07%, 58.12%) and 2 or more centers (22.21%: 13.59%, 30.83%). Methodologically, employing a larger sample size when involving more than one center could explain the smaller magnitude of undernutrition among studies conducted in multiple centers.

In the current review, the included studies defined nutritional status using different anthropometric techniques. The magnitude of undernutrition was relatively higher among studies that used AMA for age (61.66%: 47.59%, 75.72%), whereas the lowest magnitude of undernutrition was reported among studies that used BMI for age (24.84%: 17.59%, 32.09%). Studies that assessed the body composition of children with cancer reported that BMI was less sensitive to detect undernutrition than fat free mass measurements.[54] Anthropometric parameters that use arm circumference are more reliable for detecting undernutrition in children with cancer.[55] However, in tumorous cancer like brain tumor and acute lymphoblastic leukemia, in which the risk of becoming overweight was high, increased BMI was associated with treatment related mortality.[54,56,57]

Conclusion and Recommendations

Evidences from this review support high prevalence of undernutrition among children and adolescents with cancer living in SSA countries. Even though a slight reduction in the magnitude of undernutrition was observed over years, undernutrition persists to be a significant issue that might have considerably interfered with survival rate of pediatric cancer patients in resource constraints regions. Further researches are needed to provide insights to major drivers underlying undernutrition among children and adolescents with cancer. Furthermore, policy directions and cost-effective approaches that tackle undernutrition among pediatric cancer patients in a sustainable manner are needed.

Strength and Limitation of the Study

Comprehensive search for published and unpublished articles was done. Methodologically medium to high quality studies were included, which was assured by NOS for observational studies. As adequate data was not obtained on factors that were associated with undernutrition, the current review did not ascertain factors that might have been positively or negatively associated with undernutrition among pediatric patients with cancer. The small sample size of the included studies is another notable limitation of this review.

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Author Contributions

BM, MCA, LDB, and MKA contributed to study conception, literature search, data extraction and analysis. BM drafted the manuscript. AKB, EAM, ESS, EAF revised the manuscript and provided their intellectual input. All authors have read and approved the manuscript.

Availability of Data and Materials

We declare the data supporting the findings of this study are fully available within this manuscript.

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Supplemental Material

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References

1. Mudie K, Jin MM, Tan, et al. Non-communicable diseases in sub-Saharan Africa: a scoping review of large cohort studies. *J Glob Health*. 2019;9(2):020409. doi:10.7189/jogh.09.020409
2. Steliarova-Foucher E, Colombet M, Ries LAG, et al. International incidence of childhood cancer, 2001-10: a population-based registry study. *Lancet Oncol*. 2017;18(6):719-731. doi:10.1016/S1470-2045(17)30186-9
3. World Health Organization. Improving the childhood cancer cure rate. Accessed April 22, 2024. https://www.who.int/activities/improving-childhood-cancer-cure-rate
4. Farrag A, Ghazaly MH, Mohammed K, Volland R, Hero B, Berthold F. Comparing presentations and outcomes of children with cancer: a study between a lower-middle-income country and a high-income country. *BMC Pediatr*. 2023;23(1):443. doi:10.1186/s12887-023-04214-8
5. Parkin DM, Youlden DR, Chitsike I, et al. Stage at diagnosis and survival by stage for the leading childhood cancers in three populations of sub-Saharan Africa. *Int J Cancer*. 2021;148(11):2685-2691. doi:10.1002/ijc.33468
6. Omotoso O, Teibo JO, Atiba FA, et al. Addressing cancer care inequities in sub-Saharan Africa: current challenges and proposed solutions. *Int J Equity Health*. 2023;22(1):189.
7. Haileselassie W, Mulugeta T, Tigeneh W, Kaba M, Labisso WL. The situation of cancer treatment in Ethiopia: challenges and opportunities. *J Cancer Prev*. 2019;24(1):33-42. doi:10.15430/JCP.2019.24.1.33
8. Tripodi SI, Bergami E, Panigari A, et al. The role of nutrition in children with cancer. *Tumori J*. 2023;109(1):19-27.
9. Diakatou V, Vassilakou T. Nutritional status of pediatric cancer patients at diagnosis and correlations with treatment, clinical outcome and the long-term growth and health of survivors. *Children*. 2020;7(11):20201107. doi:10.3390/children7110218
10. Uzma S, Mansoor R, Jamal B, Khan L. Impact of malnutrition on survival and treatment-related morbidity of cancer in children. *J Heal Rehabil Res*. 2024;4(2):696-701. doi:10.61919/jhrr.v4i2.899
11. Brinksma A, Sanderman R, Roodbol PF, et al. Malnutrition is associated with worse health-related quality of life in children with cancer. *Support Care Cancer*. 2015;23(10):3043-3052. doi:10.1007/s00520-015-2674-0
12. Bauer J, Jürgens H, Frühwald MC. Important aspects of nutrition in children with cancer. *Adv Nutr*. 2011;2(2):67-77. doi:10.3945/an.110.000141
13. Pedretti L, Massa S, Leardini D, et al. Role of nutrition in pediatric patients with cancer. *Nutrients*. 2023;15(3):20230130. doi:10.3390/nu15030710
14. The Lancet Child & Adolescent Health. Tackling childhood cancer in sub-Saharan Africa. *Health TLCA*. 2022;(7):445.
15. Seid A, Seid O, Workineh Y, Dessie G, Bitew ZW. Prevalence of undernutrition and associated factors among adults taking antiretroviral therapy in sub-Saharan Africa: a systematic review and meta-analysis. *PLoS One*. 2023;18(3):e0283502.
16. Youn B-Y, Lee S-Y, Cho W, Bae KR, Ko SG, Cheon C. Global trends of nutrition in cancer research: a bibliometric and visualized analysis study over the past 10 years. *Int J Environ Res Public Health*. 2022;19(7):4165.
17. Mutebi M, Lewison G, Aggarwal A, et al. Cancer research across Africa: a comparative bibliometric analysis. *BMJ Glob Health*. 2022;7(11):e009849.
18. Modesti P, Reboldi G, Cappuccio F. Newcastle-Ottawa quality assessment scale (adapted for cross sectional studies). *PLoS One*. 2016;11(1):e0147601.
19. Jpt H. Cochrane handbook for systematic reviews of interventions. 2008. Accessed April 22, 2024. http://wwwcochrane-handbook org
20. Barendregt JJ, Doi SA, Lee YY, Norman RE, Vos T. Meta-analysis of prevalence. *J Epidemiol Community Health*. 2013;67(11):974-978.
21. Tola WO, Melaku T, Fufa D, Sheleme T. Adverse drug events and contributing factors among pediatric cancer patients at Jimma University medical center, Southwest Ethiopia. *BMC Pediatr*. 2023;23(1):77.
22. Yifru S, Muluye D. Childhood cancer in Gondar University Hospital, Northwest Ethiopia. *BMC Res Notes*. 2015;8:474. doi:10.1186/s13104-015-1440-1
23. Apprey C, Annan R, Arthur F, et al. The assessment and prediction of malnutrition in children suffering from cancer in Ghana. *Eur J Exp Biol*. 2014;4(4):31-37.
24. Salifu N, Segbefia CI, Tette EMA. Nutritional status at diagnosis of childhood cancer in Korle Bu Teaching Hospital,

Accra, Ghana. *Heal Sci Investig J*. 2022;3(2):365-373. doi:10.46829/hsijournal.2022.3.2.365-373
25. Israëls T, Borgstein E, Jamali M, de Kraker J, Caron HN, Molyneux EM. Acute malnutrition is common in Malawian patients with a Wilms tumour: a role for peanut butter. *Pediatr Blood Cancer*. 2009;53(7):1221-1226. doi:10.1002/pbc.22158
26. Trijn Israëls M, van de Wetering M, Peter Hesseling M, et al. Malnutrition and neutropenia in children treated for Burkitt lymphoma in Malawi. *Pediatr Blood Cancer* 2009;53:47-52.
27. Israëls T, Chirambo C, Caron HN, Molyneux EM. Nutritional status at admission of children with cancer in Malawi. *Pediatr Blood Cancer*. 2008;51(5):626-628.
28. Ellis GK, Chapman H, Manda A, et al. Pediatric lymphoma patients in Malawi present with poor health-related quality of life at diagnosis and improve throughout treatment and follow-up across all pediatric PROMIS-25 domains. *Pediatr Blood Cancer*. 2021;68(10):68. doi:10.1002/pbc.29257
29. Huibers MHW, Manda G, Silverstein A, et al. The burden of malnutrition in childhood cancer in Malawi - risk regardless of age. *Nutr Cancer*. 2022;74(9):3322-3328.
30. Chukwu B, Ezenwosu O, Ukoha O. Nutritional status of children with cancer at the university of Nigeria teaching hospital, Ituku/Ozalla, Enugu, Nigeria. *J Cancer Prev Curr Res*. 2016;5(4):00167.
31. Schoeman J, Kellerman I-M, Ndlovu S, et al. Prevalence of poverty and hunger at cancer diagnosis and its association with malnutrition and overall survival in South Africa. *Nutr Cancer*. 2023;75(7):1551-1559. doi:10.1080/01635581.2023.2214970
32. Schoeman J, Kellerman I-M, Rogers PC, et al. Prevalence of vitamin and iron deficiencies at cancer diagnosis at two pediatric oncology units in South Africa. *Pediatr Hematol Oncol*. 2023;40(8):752-765. doi:10.1080/08880018.2023.2188920
33. Beringer N, Bennett KG, Poole JE, Geel JA. Determinants of survival in children with cancer in Johannesburg, South Africa. *J Oncol*. 2021;5. doi:10.4102/sajo.v5i0.189
34. Geddara N, Mubaiwa L, Thejpal R, Hendricks C. Prevalence of malnutrition and its impact on outcomes in children with cancer in a South African setting. *S Afr J Child Health*. 2023;17(4):181-185. doi:10.7196/SAJCH.2023.v17i4.1986
35. Monko DJ, Martin HD, Mpolya EA. Correlating food and nutritional patterns with cancers in the pediatric oncology population at two specialized hospitals in Tanzania. *BMC Nutr*. 2024;10(1):10. doi:10.1186/s40795-024-00824-2
36. Raveendran Y, Gisiri R, Monko D, et al. The barriers and facilitators towards achieving optimal nutrition for pediatric oncology patients in Tanzania: a mixed methods analysis. *J Glob Oncol*. 2020;67(Supplement_1):67.
37. Israels T, Damen CW, Cole M, et al. Malnourished Malawian patients presenting with large wilms tumours have a decreased vincristine clearance rate. *Eur J Cancer Care*. 2010;46(10):1841-1847.
38. Holmes D, Matatiyo A, Mpasa A, et al. *Outcomes of a resource-adapted Wilms tumor treatment protocol in Lilongwe, Malawi, 2016-2021: successes and enduring barriers to cure*. C.L. McAtee, Baylor College of Medicine, 6838 Staffordshire Blvd, Houston, TX, United States. 2022 (Unpublished).
39. Draper K. *Incidence of malnutrition as measured using specific anthropometric and biochemical parameters and its relationship with chemotoxicity in children with nephroblastoma admitted to Inkosi Albert Luthuli Central Hospital between 2004-2012*. 2016 (Unpublished).
40. Lifson L. *Nutritional status of children with Wilms' tumour on admission to Inkosi Albert Luthuli Central Hospital in Durban, South Africa and its influence on outcome*. 2016 (Unpublished).
41. Nyaboke O. *Nutritional status and quality of life of paediatric cancer patients undergoing chemotherapy at moi teaching and referral hospital Eldoret, Kenya*. 2017 (Unpublished).
42. Ceesay A. *Development of a nutritional screening tool for pediatric cancer patients in Uganda and Tanzania: an exploratory analysis*. 2020 (Unpublished).
43. Abera EG, Sime H. The prevalence of malnutrition among critically ill children: a systematic review and meta-analysis. *BMC Pediatr*. 2023;23(1):583.
44. Zemene MA, Mengistu NW, Nigatu SG. Trends and factors associated with thinness among late adolescent girls in Ethiopia: multivariate decomposition and multilevel analysis. *Front Nutr*. 2022;9:933895.
45. Lorton CM, Griffin O, Higgins K, et al. Late referral of cancer patients with malnutrition to dietitians: a prospective study of clinical practice. *Support Care Cancer*. 2020;28(5):2351-2360. doi:10.1007/s00520-019-05042-2
46. Viani K, Albuquerque L, Barr RD, Ladas EJ. Nutrition of children with cancer in Brazil: a systematic review. *J Glob Oncol*. 2020;6:242-259.
47. Revuelta Iniesta R, Paciarotti I, Davidson I, McKenzie JM, Brougham MFH, Wilson DC. Nutritional status of children and adolescents with cancer in Scotland: a prospective cohort study. *Clin Nutr ESPEN*. 2019;32:96-106.
48. Kadenczki O, Nagy AC, Kiss C. Prevalence of undernutrition and effect of body weight loss on survival among pediatric cancer patients in northeastern Hungary. *Int J Environ Res Public Health*. 2021;18(4):20210204. doi:10.3390/ijerph18041478
49. Cotogni P, Stragliotto S, Ossola M, Collo A, Riso S. The role of nutritional support for cancer patients in palliative care. *Nutrients*. 2021;13(2):20210122. doi:10.3390/nu13020306
50. Alebel A, Demant D, Petrucka P, Sibbritt D. Effects of undernutrition on mortality and morbidity among adults living with HIV in sub-Saharan Africa: a systematic review and meta-analysis. *BMC Infect Dis*. 2021;21(1):1. doi:10.1186/s12879-020-05706-z
51. Kassa MD, Grace JM. Noncommunicable diseases prevention policies and their implementation in Africa: a systematic review. *Public Health Rev*. 2022;42:1604310. doi:10.3389/phrs.2021.1604310
52. Daniel AI, Chatenga H, Chimera B, et al. The introduction of a paediatric nutrition support program led by a clinical

dietitian at a low-resource hospital setting in Malawi. *Glob Health Action*. 2019;12(1):1656452. doi:10.1080/16549716.2019.1656452

53. Mwagomba L. *Analysis of non-communicable disease prevention policies in Malawi case study report*. 2017.
54. Murphy AJ, White M, Davies PS. Body composition of children with cancer. *Am J Clin Nutr*. 2010;92(1):55-60. doi:10.3945/ajcn.2010.29201
55. Gupta H, Pant G, Verma N. Malnutrition in childhood cancer patients: magnitude, key indicators and outcome. *Pediatr Hematol Oncol J*. 2022;7(4):155-160. doi:10.1016/j.phoj.2022.09.001
56. Iughetti L, Bruzzi P, Predieri B, Paolucci P. Obesity in patients with acute lymphoblastic leukemia in childhood. *Ital J Pediatr*. 2012;38(4):20120127. doi:10.1186/1824-7288-38-4
57. Orgel E, Genkinger JM, Aggarwal D, Sung L, Nieder M, Ladas EJ. Association of body mass index and survival in pediatric leukemia: a meta-analysis. *Am J Clin Nutr*. 2016;103(3):808-817. doi:10.3945/ajcn.115.124586