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# Unmet Needs in Nutritional Care in African Paediatric Oncology Units

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## ABSTRACT

**Background:** Up to 50% of children diagnosed with cancer in low- and middle-income countries are malnourished, which likely affects survival.
**Subjects and methods:** An online survey to paediatric oncology units (POUs) in Africa was done regarding nutritional assessment and care.
**Results:** Sixty-six surveys were received from POUs in 31 countries. Only 44.4% had a dedicated dietician for nutritional assessment and support; 29.6% undertook routine nutritional assessment during treatment. None reported defined criteria for nutritional intervention. Total parenteral nutrition was not available for 42.6% of POUs, while 51.8% did not have access to commercial enteral nutrition for inpatients, and 25.9% of the hospitals could not supply any home-based nutritional supplements.
**Conclusion:** Nutritional assessment in POUs in Africa is neither routinely undertaken nor are there defined criteria to initiate nutritional interventions. Standardized guidelines for nutritional assessment and interventions are needed for African POUs to enable improved outcome.

**KEYWORDS**: survey, paediatric oncology, nutritional care, dieticians

## INTRODUCTION

Globally >160 000 children are diagnosed with cancer each year, the majority (80–85%) live in low-income countries (LICs) and low- and middle-income countries (LMICs) [1–3]. The current cure rate for children with cancer in high-income countries is approximately 75–80% [1–6]. In LMICs, access to curative treatment is limited and poor survival rates have been reported [1, 2, 5–7]. Poor nutritional status, both under-and over-nutrition, range from 5% to 50% in paediatric cancer patients at diagnosis, with a higher prevalence of undernutrition in LMICs [6, 8–11]. The reasons for this are multifactorial [12] and influenced by the cancer diagnosis, stage of disease, co-morbidities, access to care and socio-demographic factors [11].

Poor nutritional status has an adverse effect on treatment-related toxicity and survival [1, 4, 9, 12, 13, 14, 15, 16]. Moreover, undernutrition has been associated with treatment delays [1, 4, 10, 11, 15, 16], dose adjustments [1, 4, 9, 11, 15, 16], increased hospital stay and abandonment of care [1]. Africa represents a large proportion of the global burden of undernourished children. This co-morbidity in children with cancer causes additional clinical challenges for paediatric oncologists. Up to 60% of children in Malawi were undernourished at diagnosis [6], and 25–50% in Ghana were wasted [11]. In Pretoria, South Africa, 21.6% of children were wasted and 24.3% underweight [17]. This prevalence of undernutrition highlights the need for nutritional resources so that necessary life-saving cancer therapy may be delivered.

Previous surveys have reported several barriers to the implementation of nutritional services in LICs [18, 19] but did not focus on the Africa continent or included hospitals that treat children with cancer with no paediatric oncologists. As part of a newly formed initiative between the International Society for Pediatric Oncology (SIOP) Paediatric Oncology in Developing Countries (PODC) Nutrition Working Group, SIOP Africa, and the International Initiative for Pediatrics and Nutrition Columbia University, we conducted a continental African survey.The intention of this survey was to identify the specific needs of paediatric oncology units (POUs) in Africa, develop nutritional support programmes to improve patient's nutritional status and overall survival. Nutritional support in other LIC POUs outside of Africa has resulted in improved outcomes [1, 9].

## SUBJECTS AND METHODS

The online survey was adapted from a published survey [18] and conducted between December 2016 and June 2017 and administered through surveymonkey.com. Ethics approval was obtained from the Health Research Ethics Committee of Stellenbosch University.

The survey collected and collated information on the respondent's hospital's standard of care for nutritional assessment and interventions, barriers to nutritional care and educational needs. Participants were identified by the SIOP PODC Nutrition Working Group, the SIOP PODC Supportive Group, Paediatric Oncology International Network for Training and Education website and SIOP Africa.

Responses were categorized using the World Bank classification according to income in Africa, namely, LICs, LMICs and upper-middle-income countries (UMICs) as seen in Table 1 [20]. Incomplete surveys were removed from the study. Institutions that provided multiple responses were compared for consistency and institutions contacted for clarification. The countries of Swaziland, Lesotho, Mozambique, Eritrea and Sierra Leone were excluded from this survey, as they do not offer treatment for children with cancer. Results are presented as percent distribution of the institution's response by SPSS version 25.

## RESULTS

In total, 66 (44.29%) of 149 surveys were received. Four surveys were incomplete and eight were removed as they were duplicates. The final results contained 54 surveys representing all income levels in Africa. Table 1 presents the responses by income group and region. The responses were, respectively, 35.2% ($n = 19$) for LICs, 33.3% ($n = 18$) for LMICs and 31.5% ($n = 17$) for UMICs.

### Dietetic services

The majority (66.6%; $n = 36$) of the institutions had permanently appointed dieticians to consult on in- and outpatients, <45% ($n = 28$) had a dedicated dietician for their POU. It is observed that in LICs, 84.2% ($n = 16$ of 19) had no dedicated dietician in the POU, but the number decreased in UMICs with 33.3.7% (6 of 17) and LMICs with 35.3% (6 of 18).

### Nutritional assessment

Nutritional assessment on all newly diagnosed children with cancer was performed at 51.9% of the hospitals in the inpatient setting ($n = 28$); only 33.3% attending outpatient clinics ($n = 18$) were assessed. Nutritional assessment for children during treatment was only performed when clinically indicated (61.1%) or if referred by the treating doctor (44.4%).

The parameters that are included in the nutritional assessment of children are presented in Table 2. Greater than 90% of POUs in all the different income groups relied on length/height and weight; >60% questioned on oral intake (82.4% in UMICs)

**Table 1. Survey responses by country, income group and region**

| Economy | Region | Subregion of Africa | Income group | Number of sites responded |
|---|---|---|---|---|
| Benin | Sub-Saharan Africa | West | Low income | 1 |
| Burkina Faso | Sub-Saharan Africa | West | Low income | 1 |
| Chad | Sub-Saharan Africa | Central | Low income | 1 |
| Congo, Democratic Republic | Sub-Saharan Africa | Central | Low income | 1 |
| Ethiopia | Sub-Saharan Africa | East | Low income | 1 |
| Guinea | Sub-Saharan Africa | West | Low income | 1 |
| Madagascar | Sub-Saharan Africa | East | Low income | 1 |
| Malawi | Sub-Saharan Africa | East | Low income | 3 |
| Mali | Sub-Saharan Africa | West | Low income | 1 |
| Niger | Sub-Saharan Africa | West | Low income | 1 |
| Rwanda | Sub-Saharan Africa | East | Low income | 1 |
| Senegal | Sub-Saharan Africa | West | Low income | 1 |
| Tanzania | Sub-Saharan Africa | East | Low income | 3 |
| Uganda | Sub-Saharan Africa | East | Low income | 1 |
| Zimbabwe | Sub-Saharan Africa | East | Low income | 1 |
| Cameroon | Sub-Saharan Africa | Central | Lower middle income | 2 |
| Congo, Republic | Sub-Saharan Africa | Central | Lower middle income | 1 |
| Côte d'Ivoire | Sub-Saharan Africa | West | Lower middle income | 1 |
| Egypt, Arab Republic | Middle East and North Africa | North | Lower middle income | 2 |
| Ghana | Sub-Saharan Africa | West | Lower middle income | 2 |
| Kenya | Sub-Saharan Africa | East | Lower middle income | 2 |
| Morocco | Middle East and North Africa | North | Lower middle income | 2 |
| Nigeria | Sub-Saharan Africa | West | Lower middle income | 3 |
| Sudan | Sub-Saharan Africa | North | Lower middle income | 1 |
| Tunisia | Middle East and North Africa | North | Lower middle income | 1 |
| Zambia | Sub-Saharan Africa | East | Lower middle income | 1 |
| Angola | Sub-Saharan Africa | Central | Upper middle income | 1 |
| Algeria | Middle East and North Africa | North | Upper middle income | 4 |
| Botswana | Sub-Saharan Africa | South | Upper middle income | 1 |
| Namibia | Sub-Saharan Africa | South | Upper middle income | 1 |
| South Africa | Sub-Saharan Africa | South | Upper middle income | 10 |

and nutritional symptoms (UMICs 76.5%). Greater than 55% included mid-upper arm circumference (MUAC) [68% in LIC] and laboratory indices [82.4% in UMIC]. There was a significant difference in MUAC as a parameter of nutritional status between LICs (68.1%), LMICs (61.1%) and UMICs (47.1%) ($p = 0.009$). Triceps skinfold thickness (TSF) and the use of complementary alternative medicine were reported in <25% of POUs.

### Nutritional intervention

We did not observe a consensus on the parameters used to commence advanced nutritional intervention

**Table 2. Indices used for routine nutritional assessment by units in income groups**

| Parameters of anthropometry | Income group | | | | | | Total (*N*) | % |
|---|---|---|---|---|---|---|---|---|
| | Low income (*N*) | % | Lower middle income (*N*) | % | Upper middle income (*N*) | % | | |
| Length/height | 17 | *89.5* | 17 | *94.4* | 16 | *94.1* | 50 | *92.6* |
| Weight | 16 | *84.2* | 17 | *94.4* | 16 | *94.1* | 49 | *90.7* |
| Symptoms/problems influence patient from eating | 11 | *57.9* | 11 | *61.1* | 13 | *76.5* | 35 | *64.8* |
| Oral diet/nutrient/food intake | 10 | *52.6* | 10 | *55.6* | 14 | *82.4* | 34 | *63.0* |
| MUAC | 13 | *68.4* | 11 | *61.1* | 8 | *47.1* | 32 | *59.3* |
| Laboratory indices (*e.g. albumin and pre-albumin, electrolytes*) | 6 | *31.6* | 10 | *55.6* | 14 | *82.4* | 30 | *55.6* |
| Head circumference | 7 | *36.8* | 9 | *50.0* | 6 | *35.3* | 22 | *40.7* |
| Complementary and alternative medicines (*i.e. vitamins and herbal products*) | 5 | *26.3* | 4 | *22.2* | 5 | *29.4* | 14 | *25.9* |
| TSF | 4 | *21.1* | 6 | *33.3* | 3 | *17.6* | 13 | *24.1* |
| Other | 0 | *0.0* | 1 | *5.6* | 1 | *5.9* | 2 | *3.7* |

**Table 3. Criteria for nutritional intervention**

| Parameters for intervention | Income group | | | | | | Total (*N*) | % of 54 POUs |
|---|---|---|---|---|---|---|---|---|
| | Low income (*N*) | % | Lower middle income (*N*) | % | Upper middle income (*N*) | % | | |
| Lost 10% weight | 8 | *42.1* | 10 | *55.6* | 8 | *47.1* | 26 | *48.1* |
| Change in MUAC | 7 | *36.8* | 8 | *44.4* | 8 | *47.1* | 23 | *42.6* |
| Oral food intake <80% | 8 | *42.1* | 5 | *27.8* | 7 | *41.2* | 20 | *37.0* |
| Change BMI *Z*-score or growth chart | 7 | *36.8* | 5 | *27.8* | 7 | *41.2* | 19 | *35.2* |
| Screening tool classify HR | 8 | *42.1* | 7 | *38.9* | 4 | *23.5* | 19 | *35.2* |
| Change in TSF | 7 | *36.8* | 5 | *27.8* | 5 | *29.4* | 17 | *31.5* |
| Change in BMI *Z*-score | 1 | *5.3* | 3 | *16.7* | 3 | *17.6* | 7 | *13.0* |
| No defined set criteria | 4 | *21.1* | 1 | *5.6* | 2 | *11.8* | 7 | *13.0* |

*Note:* BMI, body mass index; HR, high risk.

(Table 3). More than 40% of the POU relied on weight loss and changes in MUAC. Less than 40% of POUs evaluated oral intake and used a screening tool or other anthropometric measurements.

Total 42% ($n = 23$) of the POUs did not have access to total parenteral nutrition (TPN): 68.4% in LICs ($n = 13$ of 19) and 44.4% in LMICs ($n = 8$ of 18). Enteral products were not available in 18.5% ($n = 10$) of POUs, with 26.3% ($n = 5$ of 19) in LICs, 17.6% in UMICs ($n = 3$ of 17) and 11.1% ($n = 2$ of 18) in LMICs.

Industrialized/commercial nutritional supplements were available at 48.2% ($n = 26$) of the POUs for inpatients, and 12.9% ($n = 7$) had no supplements available. LMICs were mostly affected with 22.2% having no access to supplements ($n = 4/18$); 10.5% LICs ($n = 2$ of 19) and 5.8% in UMICs ($n = 1$ of 11). In the ambulatory setting, 35.2% ($n = 19$) of

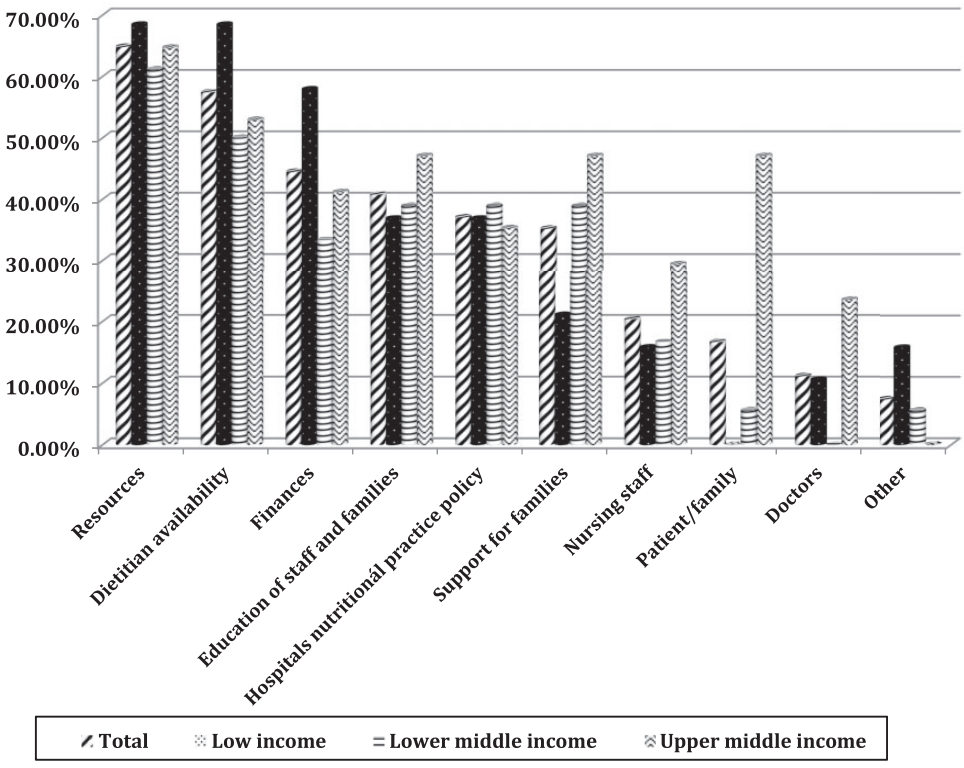


**Fig 1.** Barriers to preventing nutritional interventions.

POUs provided industrialized supplements home, and 25.9% ($n = 14$) gave no supplements. Total 44% of LMICs ($n = 8$ of 18), 21.05% of LICs ($n = 4$ of 19) and 11.7% of UMICs ($n = 2$ of 17) did not provide patients with homecare supplements. Home-made products were frequently relied on in LICs (21.1%) and LMICs (16.7%). The other products resembled World Health Organization (WHO) products, e.g. F100 for severe acute malnutrition (SAM) patients, but used in only 9.26% of POUs. The important nutritional barriers POUs experienced were lack of resources (64%); 57.1% claimed the availability of a dietician, and 44.4% had insufficient finances as seen in Figure 1. In LMICs, education of staff and families, as well as hospital nutritional policy were also factors (38.89%), and UMICs experienced lack of staff education and support to families (47.1%).

## Nutritional education

Only 38.9% ($n = 21$) of POUs reported that nutrition education was provided to all patients and/or families. In LICs, 47.4% received advice ($n = 9$ of 19) with only 33.3% in LMICs ($n = 6$ of 18) and 35.3% in UMICs ($n = 6$ of 17). The barriers to the provision of nutritional education are presented in Figure 2. Total 40% did not have sufficient personnel ($n = 22$), 31.5% had time constraints ($n = 17$) and 29.6% did not have sufficient educational material to give to patients ($n = 16$). In UMICs 47.1% and LMICs 38.9% experienced lack of personnel, while 47.1% in UMICs and 22.2% in LMICs reported time constraints as the most significant barriers. In LICs, lack of educational material (42.1%) and financial resources (31.6%) was the primary barriers.

Non-profit organizations (NGO) play a major role in POUs at hospitals when all the children's treatment and supportive care needs cannot be met. The greatest need indicated by this survey in LICs was enteral products for both in- and outpatients; 31.5% ($n = 6$ of 19) and 21.1% (4 of 19), respectively, 27.7% of LMICs requested TPN ($n = 5$ of 18), while 35.3% in UMICs ($n = 6$ of 17)

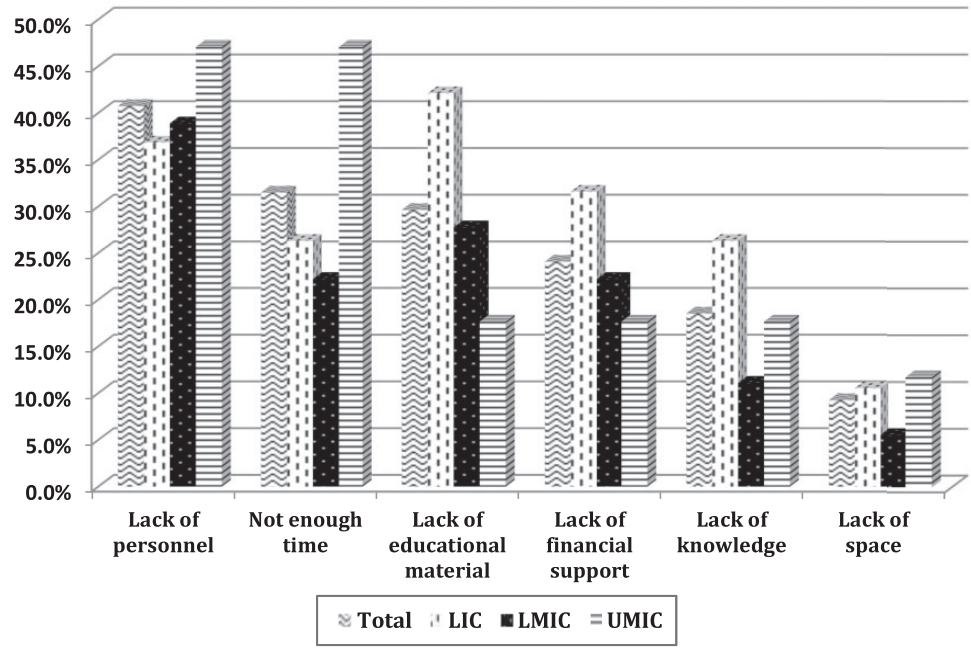


**Fig 2.** Barriers to nutritional education not given to patients.

considered that groceries for home would improve their patient's nutritional status.

## DISCUSSION

The survey was representative of the different defined income groups in Africa. Less than half of the hospitals had a full-time dietician in the POU, which is lower than previously reported surveys that included sites in Africa [18, 21]. This can be because of the majority of the POUs responding were from LIC, which experience a lack of healthcare personnel because of limited resources. This likely explains our observation that newly diagnosed children with cancer are not uniformly nutritionally assessed and monitored during treatment. This is of great concern in light of the 2015 sub-Saharan Africa report: 21% of children <5 years of age were underweight, 39% stunted and 9% wasted [22].

The SIOP nutritional algorithm recommends the use of MUAC to classify the nutritional risk in children with cancer [23] because of its independence of tumour mass [1, 6, 12, 19], temporary gains in total body water [24] and ethnicity [1, 19]. In the survey most POUs still relied on weight and length/height as parameters. The use of MUAC for nutritional assessment is significantly higher than reported literature, 59.3% compared with 33% [18] with a significant difference between income groups. It is not sufficiently used as criteria for nutritional interventions. Our study confirms that there are no uniform standards of nutritional assessment and monitoring during treatment; parameters for initiating nutritional interventions such as weight loss were relied on in half of the institutions. This indicates the need for education on the importance of monitoring nutritional status during treatment.

Our survey identified several barriers to nutritional intervention. The majority of the POUs do not have access to the full range of TPN or commercial enteral nutritional products, which underlines the need for POU to use home-made products. Other approaches have been the provision of food products to patients and their families. In Cameroon, children were provided one egg, 200 ml of WHO F100 milk and families received the equivalent of US$1 per day to purchase food. This combined program (protein, nutritional supplement and money) led to increased MUAC and/or TSF in almost two-thirds of the children while on cancer treatment, and a suggestion of decreased treatment-related mortality [6].

The management of SAM patients remains a challenge for POUs, as studies have found that the SAM-WHO regime is not routinely available because of few hospital beds, lack of trained staff, costs of the WHO products and overall management thereof. For example, the cost of treatment of SAM is US$203 per child in Zambia and US$284 in Ethiopia [25]. Nutritional rehabilitation of children with SAM and access to F100 formula are mostly undertaken at small hospitals and clinics where the nursing staff are trained. In contrast, most nurses in POUs are not trained to treat SAM patients or POUs to receive WHO products. African POUs are in need of organizations, such as SIOP-Africa, to assist POUs in adopting models of care and increase their resources [19] to optimize nutritional care.

We observed that less than half of the POUs provide nutritional advice to families of patients, a figure aligned with a previous survey by the investigators [18]. This was explained by a lack of personnel and time, which is because of time spent on medical care of the patients and insufficient time with families. We found that majority in UMICs thought groceries for patients will improve their nutritional status, suggesting that food insecurity may impact nutritional care. Our survey highlights the need for collaborative initiatives with several stakeholders, especially NGOs to provide nutritional resources to support overall care in POUs.

In conclusion, our results provided important information on the relevant barriers to nutritional assessment, intervention and/or education at POUs in the different income groups within Africa. This information will be used to establish modifiable and adapted nutritional guidelines and education of all cancer healthcare staff in the different POUs. Once established, this will improve the understanding of the importance of nutrition in children and subsequently enable future research. We are planning a national nutrition study in South Africa and Cameroon to commence late in 2018 to evaluate in greater detail the nutritional status of patients at cancer diagnosis. Patients' nutritional status will be monitored longitudinally during treatment to determine the effect on clinic on clinical outcome. Nutritional studies in other Africa countries will follow.

## LIMITATIONS

The limitations of the study are the identification of institutions caring for children with cancer using internet groups. As the survey was Internet-based that might affect the number of responses received because of limited availability thereof. An additional limitation is the inability to verify all of the information.

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## REFERENCES

1. Pribnow AK, Ortiz R, Báez LF, *et al*. Effects of malnutrition on treatment-related morbidity and survival of children with cancer in Nicaragua. Pediatr Blood Cancer 2017;64:1–7.
2. Howard SC, Marinoni M, Castillo L, *et al*. Meeting report: improving outcomes for children with cancer in low-income countries in Latin America: a report on the recent meetings of the monza international school of pediatric hematology/oncology (MISPHO)-PART 1. Pediatr Blood Cancer 2007;48:364–9.
3. Sala A, Antillon F, Pencharz P, *et al*. Nutritional status in children with cancer: a report from the AHOPCA workshop held in Guatemala City, August 31-September 5, 2004. Pediatr Blood Cancer 2005;45:230–6.
4. Slegtenhorst S, Visser J, Burke A, *et al*. Antioxidant intake in paediatric oncology patients. Clin Nutr 2015;34:1210–4.
5. Stefan DC. Epidemiology of childhood cancer and the SACCSG Tumour registry. CME 2010;28:317–9.
6. Israles T, Renner L, Hendricks M, *et al*. SIOP PODC: recommendations for supportive care of children with cancer in a low-income setting 2013. Paediatr Blood Cancer. wileyonlinelibrary.com/10.1002/pbc.24501
7. Stefan DC, Stones DK, RD W, *et al*. Childhood cancer incidence in South Africa, 1987-2007. 2015;105:939–47.
8. Rogers PC, Schoeman J, Nutritional assessment and intervention. In: Stefan D C, Rodrigues-Galindo C (eds). Pediatric Hematology-Oncology in Countries with Limited Resources. New York: Springer, 2014, p. 91–112.
9. Antillon F, Rossi E, Molina AL, *et al*. Nutritional status of children during treatment for acute lymphoblastic leukaemia in Guatemala. Paediatr Blood Cancer 2013;60:911–5.

10.Sala A, Rossi E, Antillon F, *et al*. Nutritional status at diagnosis is related to clinical outcomes in children and adolescents with cancer: a perspective from central America. Eur J Cancer 2012;48:243–52.
11.Chukwu BF, Ezenwosu OU, Ukoha OM, *et al*. Nutritional status of children with cancer at the university of Nigeria teaching hospital, Ituku/Ozalla, Enugu, Nigeria. J Cancer Prev Curr Res 2016;5:1–8.
12.Lifson LF, Hadley GP, Wiles NL, *et al*. Nutritional status of children with wilms' tumour on admission to a South African hospital and its influence on outcome. Pediatr Blood Cancer 2016;00:1–8.
13.Gaynor EPT, Sullivan PB. Nutritional status and nutritional management in children with cancer. Arch Dis Child 2015; 100:1169–72.
14.Kruger M, Reynders D, Nel R, *et al*. Effect of nutritional status of paediatric patients at cancer diagnosis on outcome. J036. Pediatr Blood Cancer, p184.
15.Ward E, Hopkins M, Arbuckle L, *et al*. Nutritional problems in children treated for medulloblastoma: implications for enteral nutrition support. Paediatr Blood Cancer 2009; 53:570–5.
16.Morrison J, Nayiager T, Webber CE, *et al*. Creatinine as a measure of lean body mass during treatment of acute lymphoblastic leukemia in childhood. J Pediatr Hematol Oncol 2011;33:e13e–6.
17.Schoeman J. The effect of the nutritional status of paediatric patients with cancer on disease outcome. Unplublished MSc Dissertation. Bloemfontein: University of the Free State, 2008.
18.Murphy AJ, Mosby TT, Rogers PC, *et al*. An international survey of nutritional practices in low- and middle-income countries: a report from the International Society of Pediatric Oncology (SIOP) PODC Nutrition Working Group. 2014;(April). Eur J Clin Nutr 68:1341–5.
19.Ladas EJ, Arora B, Howard SC, *et al*. A framework for adapted nutritional therapy for children with cancer in low- and middle-income countries: a report from the SIOP PODC Nutrition Working Group. Pediatr Blood Cancer 2016;63: 1339–48. wileyonlinelibrary.com/10.1002/pbc.26016.
20.World Bank. World Bank list of economies (June 2017). Washington: World Bank, 2017.
21.Schoeman J, Reynders D. Analysis of dietetic services in paediatric oncology units in South Africa. In: Poster Presented Session: Africa Conference of the International Society of Paediatric Oncology, 2012 March 19-21, Cape Town, South Africa.
22.Jesson J, Masson D, Adonon A, *et al*. Prevalence of malnutrition among HIV-infected children in central and West-African HIV-care programmes supported by the growing up programme in 2011: a cross-sectional study. BMC Infect Dis 2015;15:1–12.
23.Fleming CAK, Viani K, Murphy AJ, *et al*. The development, testing, and preliminary feasibility of an adaptable pediatric oncology nutrition algorithm for low–middle income countries. Indian J Cancer 2015;52:225–8. .
24.Connor NE, Manary MJ, Maleta K. Monitoring the adequacy of catch-up growth among moderately malnourished children receiving home-based therapy using mid-upper arm circumference in Southern Malawi. Matern Child Health J 2011;15:980–4. https://www.ncbi.nlm.nih.gov/pubmed/20082126
25.Garg CC, Mazumde S, Taneja S, *et al*. Costing of three feeding regimens for home-based management of children with uncomplicated severe acute malnutrition from a randomised trial in India. BMJ Glob Heal 2018;3:1–10.