Prevalence of Poverty and Hunger at Cancer Diagnosis and Its Association with Malnutrition and Overall Survival in South Africa

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Abstract

Many South African children live in poverty and food insecurity; therefore, malnutrition within the context of childhood cancer should be examined. Parents/caregivers completed the Poverty-Assessment Tool (divided into poverty risk groups) and the Household Hunger Scale questionnaire in five pediatric oncology units. Height, weight, and mid-upper arm circumference assessments classified malnutrition. Regression analysis evaluated the association of poverty and food insecurity with nutritional status, abandonment of treatment, and one-year overall survival (OS). Nearly a third (27.8%) of 320 patients had a high poverty risk, associated significantly with stunting ($p = 0.009$), food insecurity ($p < 0.001$) and residential province ($p < 0.001$) (multinomial regression). Stunting was independently and

significantly associated with one-year OS on univariate analysis. The hunger scale was significant predictor of OS, as patients living with hunger at home had an increased odds ratio for treatment abandonment (OR 4.5; 95% CI 1.0; 19.4; $p = 0.045$) and hazard for death (HR 3.2; 95% CI 1.02, 9.9; $p = 0.046$) compared to those with food security. Evaluating sociodemographic factors such as poverty and food insecurity at diagnosis is essential among South African children to identify at-risk children and implement adequate nutritional support during cancer treatment.

Introduction

'Absolute poverty' is described as "a condition characterized by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education, and information" (1). According to the South African census (2015), 30 million people live on less than R84.11 (US$5) per day (2) and 55% of South African children live below the ultra-poverty line (3) (R800/month or US$45.81/month) (4). Socioeconomic status has been associated with poor nutritional status in children with cancer (5–7) and poorer cancer outcomes. Malnutrition at diagnosis has been identified as a modifiable prognostic risk factor (5). Recognizing these factors, South Africa implemented the Child Support Grant (CSG) in 1998 to reduce child poverty by covering food costs (6). The CSG does not cover additional expenses incurred due to a life-threatening illness such as cancer (7).

Poor diet diversity is also strongly associated with low socioeconomic status (8). The effects of poor diet quality may be exacerbated among South African children, as poor diet quality is also linked to several micronutrient deficiencies (9) due to families relying on a small variety of foods, consuming less-expensive foods, and decreasing portion sizes (10–12). Recent literature has found that a high-quality diet may confer a protective effect against some treatment-related toxicities of cancer treatment (13). The effects of these factors within the context of a child undergoing cancer treatment in a low- and middle-income country have yet to be determined.

Identifying modifiable risk factors that lead to poor nutrition in childhood cancer is an understudied area, especially in low- and middle-income countries. It therefore is necessary to understand the scope of poverty and hunger, and their association with nutritional status among children undergoing cancer treatment. This knowledge will assist in efficiently allocating hospital resources and establishing support networks to ensure that the most vulnerable children are supported through proactive nutrition interventions while undergoing cancer treatment. As half of South Africans experience chronic poverty over time (14), food insecurity will be affected; we investigated the prevalence of poverty and food insecurity at cancer diagnosis, their association with malnutrition at the time of diagnosis, as well as the abandonment of treatment and overall survival (OS) at one year post-diagnosis.

Methods

Study Design

This cross-sectional study, nested in a prospective cohort study, recruited children newly diagnosed with cancer and aged between three months and 15 years in five of 13 pediatric

oncology units (POUs) in South Africa from October 2018 to December 2020. Their parents' or caregivers' written consent was obtained prior to study enrollment, and assent was obtained from children older than seven years. The following institutions provided ethics approval: Stellenbosch University, Faculty of Medicine and Health Sciences (Health Research Ethics Committee [S18/04/050]), the University of Pretoria (Research Ethics Committee, [281/2018]), the University of the Witwatersrand (Human Research Ethics Committee [M190485]), the University of the Free State (Health Sciences Research Ethics Committee [UFS-HSD2019/0445/3007]) and Frere Hospital (Ethics Committee [CMHREC 001/19]). The national and provincial health departments gave approval for the study to be conducted in the public sector.

Study Instruments

A structured interview with the parent or legal guardian was held within 72 h of diagnosis in the language of their choice (e.g., English or native South African language). The Simple Poverty Scorecard® Poverty-Assessment Tool South Africa (15), a validated questionnaire consisting of 12 questions, was administered by an investigator to determine the risk of living in poverty. Participants selected answers from a series of multiple-choice questions that were allocated a score and then summed, creating a composite score for each participant. Scores were classified based on previously published data (15) and reflected the risk of living in poverty or below the poverty line of US$2/day. A score of 0 to 35 was classified as a high risk (≥ 64.8% risk) of living below the poverty line; a score of 36 to 50 indicated a medium risk (≥ 18.4% risk); and a score of 51 to 100 indicated a low risk (< 18.3%) of living below the poverty line (15). Additional information on household income was collected during the structured interview to determine the proportion of families receiving salaries or wages, and those who only received the CSG and therefore lived on less than US$2/day.

The Household Hunger Scale questionnaire (16) was also administered during the same interview and consisted of eight questions from the Community Childhood Hunger Identification Project (17) to determine food insecurity at home. Participants responded 'yes' or 'no' to eight questions and were classified into three groups: Group 1: Five to eight 'yes' responses, which indicated that food insecurity affected everyone in the household, with the classification 'hungry'; Group 2: One to four 'yes' responses, which indicated that the family was at 'risk of hunger'; and Group 3: All 'no' responses, which indicated food security in the household (16).

Clinical Data

Clinical data (diagnosis, stage or risk of disease, and chemotherapy protocol) was obtained from the medical files containing demographic data (age, sex and province of residence) and added to the study database. OS was defined as patients alive one year post-cancer diagnosis.

The nutritional anthropometric assessment was evaluated within 72 h after diagnosis, including weight, height and mid-upper arm circumference (MUAC). Children older than two years were weighed on a SECA column scale with a height meter (SECA 786 and SECA 220). Children younger than two years were weighed with a SECA electronic baby scale with a length meter attached (SECA 334). The length was measured while the child was lying flat on

the scale. The UNICEF color band measured the MUAC of children under five (3), and a measuring tape (18) was used to obtain the MUAC in older children. All assessments were plotted on the WHO growth charts (19), and the WHO Anthro program was utilized to determine z-scores for height for age (HAZ), body mass index (BMI) for age (BAZ), and MUAC for age (MUAC/A) (20). The MUAC for children older than five was plotted on the Mramba et al. growth charts (21) and divided into categories. In this study, poor nutritional status was defined as stunting (HAZ < −2 SD) and malnutrition (BMI for age and/or MUAC/A < −2 SD) (22). (It is known that tumor weight and/or ascites can influence weight; therefore, we defined malnutrition according to BMI or MUAC.)

Statistical Analysis

Data was analyzed using STATA version 17.0 (STATA Corp. Texas, USA). Descriptive statistics (frequencies, percentages, means, medians and standard deviations) for demographics, anthropometrics, diagnosis, the results of the Poverty Assessment Tool, and the Household Hunger Scale variables were calculated. The total cutoff point of the scores from the Poverty Assessment Tool and the Household Hunger Scale was used. Proportions below and above the cut points were calculated, and the prevalence and Wilson 95% confidence intervals (CIs) were determined. The results were pooled over the five POUs, and chi-square tests were used to determine the association of sex, age, gestational age, disease group, diagnosis, anthropometric variables, and hunger risk with poverty risk. Relative risk ratios (RRR) and 95% CIs were calculated using a multinomial logistic regression analysis, using the low-poverty-risk group as the baseline comparison group. The Western Cape, one of the wealthiest provinces in South Africa (23), was used as the reference province for regression analysis regarding regional poverty assessment. An investigation was done to determine factors associated with the abandonment of therapy using a logistic regression analysis estimating odds ratios and 95% CIs. OS was investigated for the different poverty risk groups one year after diagnosis. The association between one-year OS, poverty risk, and food insecurity was assessed using log-rank tests and a Cox regression analysis, reporting hazard ratios and a 95% CI. For the Cox regression model, the baseline risk factors were adjusted for the stage or risk of disease at diagnosis. All non-correlating factors in the univariate analysis with a p-value < 1.0 were included in the regression analysis. A significance level of 5% or $p < 0.05$ was applied.

Results

Demographics

We enrolled 320 children and adolescents during the study period, with a male-to-female ratio of 1.1:1 and a median age of 5.3 years (range three months to 15 years). The majority were diagnosed with a solid tumor (55.9%), and 44.1% had a hematologic malignancy (Table 1). The most common diagnoses were acute lymphoblastic leukemia (23.1%), nephroblastoma (15.6%), and Hodgkin lymphoma (7.8%) (Supplementary Table S1).

Table 1. Demographics of the study population.

Demographics categories		N (Percentage)
Sex:	Males	168 (52.5%)
	Females	152 (47.5%)
Gestational age at birth:	Full term	259 (80.9%)
	Premature	61 (19.1%)
Age in years	Median (IQR)	5.3 (2.6 – 9.1)
	Mean (range)	6.14 (0.3 – 15.7)
Age groups	<5 years	154 (48.1%)
	≥5 years	166 (51.9%)
Hospital	Steve Biko Academic Hospital	154 (48.1%)
	Tygerberg Hospital	107 (33.4%)
	Chris Hani Baragwanath Hospital	29 (9.1%)
	Universitas Hospital	21 (6.6%)
	Frere Hospital	9 (2.8%)
Province of residence	Western Cape	106 (33.1%)
	Mpumalanga	92 (28.8%)
	Gauteng	82 (26.5%)
	Free State	19 (5.9%)
	Eastern Cape	10 (3.1%)
	Limpopo	4 (1.3%)
	North West	6 (1.9%)
	Northern Cape	1 (0.3%)
Disease group	Hematological malignancy	141 (44.1%)
	Solid tumor	179 (55.9%)

Abbreviations: IQR: Interquartile range.

Table 2. Results of the Simple Poverty Scorecard ® Poverty-Assessment Tool South Africa.

Total score for Poverty-Assessment Tool	The risk of living below the poverty line associated with the score *(column 1)* (US$2/day)	Group division	Group title	Percentage score for risk under the poverty line per group	N	%
0–20	95.9%	0–35	High poverty risk	≥ 64.8%	89	27.8
21-28	82.1%					
29–35	64.8%					
36–37	55.9%	36–50	Medium poverty risk	≥ 18.4%	106	33.1
38–40	50.8%					
41– 45	35.7%					
46–48	29.2%					
49–50	18.4%					
51–53	16%	51–100	Low poverty risk	< 18.3%	125	39.1
54–58	6.7%					
59–61	3.8%					
62–66	3.2%					
67–68	0.5%					
69–100	0%					

Abbreviations: US$2: United States of America dollar.

Poverty

Nearly a third of the families (27.8%) had a high risk of living in poverty, a third (33.1%) had a medium risk, and 39.1% had a low risk (Table 2). More than a third of the children (35.9%) lived in households with more than six residents and reported no male head or spouse living with them (39.6%). Most female-headed households were proficient in English as a second language (70.9%) (Supplementary Table S2). Half of the families received a monthly salary (51.6%), 22.2% performed occasional informal work, and 10.6% had a household member receiving an older person's grant (namely, South African Social Security Agency pension for persons older than 60 years (24)). Most families received a CSG (58.2%) (Supplementary Table S3). The reported monthly median income was R3,000 (US$164.10) (IQR R1,280 to R5,600 or IQR US$70.02 to US$306.32), and 19% ($n = 61$) of the families lived on less than US$2/day. Nearly all families in the study owned essential and luxury items such as mobile phones (98.8%), fridges (85.6%), cooking stoves (88.1%), lounge suites (couches, 64.4%), and satellite television (56.9%) (Supplementary Table S2).

Hunger

Most children lived in households with a high risk of food insecurity (80%), with 37.2% living with hunger at home, 42.8% living with a risk of food insecurity, and a mere 20% living in households with food security (Supplementary Table S4). Most parents (71%) reported using a limited variety of foods to feed their children due to a lack of financial means. More than half (65.9%) of the households experienced a monthly shortage of funds for food, and most caregivers (56.6%) decreased their meal portions or skipped meals to be able to feed their families. Most parents (86.6%) ensured that their children never went to bed hungry, even though their financial means were limited. Of concern, however, is that most children (69.4%) experienced occasional hunger, and 68.4% of the parents also decreased the meal portions of their children due to a lack of funds. More than half of the parents (61%) indicated that their children ate less than they should due to inadequate financial means (Supplementary Table S5).

Demographic Associations with Poverty and Hunger

From the univariate analysis, the risk of poverty was significantly associated with the Household Hunger Scale score ($p < 0.001$) and the province of residence ($p < 0.001$), but not with age, sex, diagnosis, disease group or stage/risk of disease (Table 3 and Supplementary Table S6). Hunger was significantly associated with age ($p = 0.035$) and the province of residence ($p < 0.001$), but not with sex, disease group or diagnosis (Supplementary Table S7). Patients who experienced hunger were most likely to be in the high-poverty-risk group (RRR 20.2, 95% CI 6.2, 66; $p < 0.001$) than in the low-poverty-risk group. The risk of hunger decreased as the risk of poverty decreased, as the medium-poverty-risk group had a lower risk of hunger than the high-poverty-risk group (RRR 9.7, 95% CI 3.8, 24.9, $p < 0.001$) in the multinomial regression analysis. Children living in Mpumalanga (RRR 14.6, 95% CI 4.4, 48.3; $p < 0.001$) were most likely to be in the high-poverty-risk group, followed by those living in the Free State (RRR 11.8, 95% CI 2.3, 59.3; $p = 0.003$) and the Eastern Cape (RRR 10.2, 95% CI 1.7, 62.9; $p = 0.012$), while patients from Gauteng had a non-significant lower risk for falling in the high-poverty-risk group (RRR 2.5, 95% CI 0.9, 6.9; $p = 0.073$) (Table 4).

Table 3. Association of demographics, Household Hunger Scale, and nutritional status with risk of living in poverty.

Category		High risk		Medium risk		Low risk		$N=320$	p-value
		N	%	N	%	N	%		
Age	< 5 years	44	28.6	51	33.1	59	38.3	154	0.949
	≥ 5 years	45	27.1	55	33.1	66	39.8	166	
Sex	Male	43	25.6	64	38.1	61	36.3	168	0.139
	Female	46	30.3	42	27.6	64	42.1	152	
Gestational age	Term baby	80	30.9	87	33.6	92	35.5	259	0.011
	Premature	9	14.8	19	31.2	33	54.1	61	
Provinces	Eastern Cape	5	50.0	2	20.0	3	30.0	10	< 0.001
	Free State	10	52.6	4	26.3	5	26.3	19	
	Gauteng	20	24.4	24	29.3	38	46.3	82	
	Mpumalanga	40	43.5	37	40.2	15	16.3	92	
	Western Cape	12	11.3	35	33.0	59	55.7	106	
	Other	2	18.2	4	36.4	5	45.5	11	
Household Hunger Scale	No risk of hunger	6	9.4	11	17.2	47	73.4	64	< 0.001
	Risk of hunger	28	20.4	50	36.5	59	43.1	137	
	Food insecurity	55	46.2	45	37.8	19	16.0	119	
Length for age	Normal	67	24.5	91	33.3	115	42.1	273	0.003
	Stunted	22	46.8	15	31.9	10	21.3	47	
BMI for age	Normal	73	25.8	94	33.2	116	41.0	283	0.053
	Wasted	16	43.2	12	32.4	9	24.3	37	
MUAC for age	Normal	60	24.4	78	31.7	108	43.9	246	0.001
	Malnutrition	27	39.1	28	40.6	14	20.3	69	

Abbreviations: BMI: Body mass index; MUAC: Mid-upper arm circumference. A p-value of <0.05 was considered statistically significant.

Table 4. Multiple multinomial logistic regression of poverty risk on sociodemographic and anthropometry indicators at baseline with the low-poverty risk group as the reference group.

Variables	Parameters	*RRR (95% CI)	*p*-value	RRR (95% CI)	*p*-value
Province	Western Cape*	1		1	
	Free State	11.8 (2.3, 59.3)	0.003	2 (0.4, 10.2)	0.394
	Gauteng	2.5 (0.9, 6.9)	0.073	1.1 (0.5, 2.6)	0.752
	Mpumalanga	14.6 (4.4, 48.3)	< 0.001	5.3 (1.9, 14.3)	0.001
	Eastern Cape	10.2 (1.7, 62.8)	0.012	1.1 (0.1, 7.9)	0.945
	Other	1.1 (0.1, 9.4)	0.910	1.5 (0.3, 7.8)	0.625
Gestational age	Term*	1		1	
	Premature	0.6 (0.2, 1.5)	0.252	0.6 (0.3, 1.3)	0.193
Household Hunger Scale	No risk for hunger*	1		1	
	Risk of hunger	3.7 (1.2, 11.5)	0.023	3.5 (1.5, 8.1)	0.004
	Hunger	20.2 (6.2, 66)	< 0.001	9.7 (3.8, 24.9)	< 0.001
Length/Height for age	Normal	1		1	
	Stunted	3.7 (1.4, 10)	0.009	1.8 (0.7, 4.6)	0.219
BMI for age	Normal	1		1	
	Malnutrition	1 (0.3, 3.5)	0.941	0.5 (0.2, 1.8)	0.313
MUAC for age	Normal	1		1	
	Malnutrition	2.5 (0.9, 7)	0.086	3.6 (1.4, 9.4)	0.009

Abbreviations: *RRR: relative risk ratio; BMI: Body mass index; MUAC: mid-upper arm circumference. *A p*-value of <0.05 was considered statistically significant..

Associations between Nutritional Status, Poverty and Hunger

In the univariate analysis, children with stunting ($p = 0.003$) and with malnutrition ($p = 0.001$) at diagnosis were significantly associated with the risk of living in poverty (table 3). The score for the Household Hunger Scale ($p = 0.018$) was significantly associated with malnutrition, but not with stunting (Supplementary Table S7). In terms of the multiple regression analysis, children at high risk of living in poverty were more likely to be stunted (RRR 3.7, 95% CI 1.4, 10.0; $p = 0.009$), while children with malnutrition at diagnosis (RRR 3.6, 95% CI 1.4, 9.4; $p = 0.009$) were more likely to be in the medium-poverty-risk group than in the low-poverty-risk group (Table 4).

Abandonment of Treatment and Survival

The one-year post-cancer diagnosis outcome was available for all children who participated in the study ($n = 320$; 100%). The majority (77.5%; $n = 248$) were alive, 22.5% had died ($n = 72$), 8.8% had abandoned therapy ($n = 28$), and 3.4% had relapsed ($n = 11$). Most of the children who abandoned therapy were from the provinces of Mpumalanga (33%) and the Free State (15%), were older than five years of age (85.7%), and were well-nourished (52%). The univariate analysis indicated that the Household Hunger Scale score ($p = 0.031$) and the residential province score ($p = 0.025$) were significantly associated with treatment abandonment, but not with the poverty risk. In the multivariate analysis, children with food insecurity at home were 4.5 times more likely to abandon treatment (RRR 4.5, 95% CI 1.03, 19.4; $p = 0.045$). This was also the case for children from the Free State province, who had an increased risk of treatment abandonment (RRR 15.7, 95% CI 3.5, 70.6; $p < 0.001$) (Supplementary Table S8).

The one-year OS for the entire cohort was 77.5% (95% CI 72.5, 82.0). Stunting was independently and significantly associated with OS on univariate analysis. Children with normal length or height had an increased survival rate (79.5%, 95% CI 74.2, 84.1) compared to stunted children (65.9%; 95% CI 50.7, 79.1) ($p = 0.018$), but significance was not confirmed with Cox regression (Supplementary Table S9). There was no significant difference in OS between children with malnutrition, age groups, sex, province of living, or disease group on the log-rank test. From the Cox regression model, the hunger scale was a significant predictor of OS. Patients living with hunger at home at diagnosis had an increased risk of death (HR 3.2 (95% CI 1.0, 9.9; $p = 0.046$) compared to those with food security, adjusted for stage or risk of disease at diagnosis. Poverty risk at baseline, however, was not a significant predictor of OS.

Discussion

According to the World Bank poverty report on South Africa (2), children, in general, are at a high risk of living in poverty, hunger, and poor nutritional status (25). Aligned with this report, we found that a third of our population was in the high-poverty-risk group. At the same time, 80% lived with either food insecurity or a risk of food insecurity, which is strongly associated with abandoning treatment. Moreover, we found that the risk of poverty was significantly associated with stunting and malnutrition, potentially increasing the risk of treatment-related toxicities and poor outcomes. Nutritional intervention should be implemented from diagnosis to improve patients' nutritional status and survival (26). Our study identified that a large

proportion of children with cancer experienced poverty and food insecurity at diagnosis, which may be exacerbated by the long duration of treatment for childhood cancer. Our study underscores the need for medical centers to enhance collaboration with organizations that provide financial and/or food aid support to families throughout treatment to enhance outcomes.

Although South Africa is classified as an upper-middle-income country, 26% of the population lives below the internationally defined poverty line of US$1/day (27), and 19% of the families in this study lived on less than US$2/day. The lower prevalence in our study may be because 50% of the participants received the CSG to supplement their household income. However, the CSG barely covers a child's basic needs (6), and a cancer diagnosis will likely strain families' finances (7). Future studies should evaluate how this fluctuates during treatment and examine the clinical repercussions of profound poverty on nutritional status and cancer outcomes among South African children progressing through treatment for cancer.

We found that the high-poverty-risk group was significantly associated with food insecurity at home, a finding that is similar to that of previous studies in Limpopo (12) and Mpumalanga, two of the nine South African provinces (16). Socioeconomic status was reported to affect nutritional status (28) and in this study, significantly more patients with stunting and malnutrition lived in the groups with a higher risk for poverty. Similar results were seen in healthy teenagers from medium and low socioeconomic status who suffered from wasting in Bloemfontein (Free State province) (26). The authors also found that stunting was associated with household food security (28). This study illustrated that children with stunting and malnutrition at cancer diagnosis were more likely to live in poverty, thereby highlighting a group of children needing social services and support networks over and above the existing structures available to South African children with cancer.

Our study found that South African children with malnutrition at cancer diagnosis often experienced food insecurity at home, underscoring the need to address primary rather than secondary malnutrition due to underlying cancer. This observation was especially apparent among children from rural provinces. Many children in our study experienced high poverty and a food insecurity risk at diagnosis; thus, nutritional counseling targeting dietary intake in the home setting should be a priority for these patients. Future studies need to consider evaluating the impact of poverty and hunger on dietary intake during treatment, and to proactively prevent malnutrition or micronutrient deficiencies from developing. In turn, improved clinical outcomes may be observed.

A survey in Tanzania reported that poverty is one of the risk factors for stunting (28), demonstrated in this study by an association between stunting and the high-poverty-risk group. A recent study on healthy infants from Mpumalanga (a province in South Africa) found a significant association between stunting and maternal education, parental employment, and access to water at home. Stunting may also be due to poor maternal nutrition, late onset of complementary feeding practices for infants, lack of protein in the diet, or impaired nutrient absorption (29).

As an indicator of chronic malnutrition, stunting causes tissue damage and reduces the function of neurotransmitters (29). Stunting is also associated with reduced lung growth and

function, which can influence the prevalence of pulmonary infections (31), affect morbidity, and increase the risk for mortality (30). Stunting affects cognitive development, with poorer academic achievement and economic productivity, which are fundamental aspects for the cured child with cancer (31).

Therefore, future studies should focus on the improvement of stunting in newly diagnosed children with cancer through planned interventions, as this is a modifiable risk factor to enhance OS and survivors' quality of life.

Although we have not observed a significant effect of poverty risk on OS, we have found that food insecurity increases the risk of treatment abandonment and decreases OS. This is a crucial finding, as previous studies have reported that increased counseling and resources for children at high risk of treatment abandonment reduce its prevalence (7). Several studies have also reported a positive association between sociodemographic factors and OS (32–34). In a previous South African study of children from families with higher socioeconomic status (household income of US$191/year or US$6/day) with germ cell tumors, it was found that they experienced significantly improved OS at five years (p = 0.039) (32). Indonesian children from low-income families diagnosed with acute lymphoblastic leukemia have also experienced significantly lower event-free survival two years or longer after diagnosis than those from higher-income families (33). Our study has documented that food insecurity can predict OS, but not poverty, indicating that the Hunger Scale is a better tool to use to identify at-risk children in South Africa. As hunger at home is significantly associated with increased risk for treatment abandonment and risk of death, the Hunger Scale should be completed at cancer diagnosis to plan nutritional and other supportive interventions to improve OS.

We recognize several limitations of this study of poverty and hunger. The South African POUs that participated in this study self-selected to participate and provided preliminary information on poverty and hunger. Our findings there are limited to the regions that participated. Our cohort consisted of a heterogenous sample with a variety of diagnoses and severity of the disease. Due to funding and personnel limitations, we did not evaluate diet history; thus, the impact of poverty, food insecurity, and poor nutritional status on dietary diversity is unknown.

A strength of our study is the use of validated questionnaires (15, 16) which could serve as comparison data in future studies. Future studies could also consider evaluating sociodemographic factors, especially the risk of hunger (16), along with nutritional assessment within a homogenous cohort to control for the heterogeneous variables in this study.

In conclusion, we found a high prevalence of poverty and hunger among South African children diagnosed with cancer. Food insecurity was associated with an increased risk of treatment abandonment and decreased risk of OS. A significant association was noted between the high-poverty-risk group and stunting, while stunting was associated with poorer OS. Our findings underscore the importance of incorporating an assessment of the risk of living in poverty and/or with food insecurity at diagnosis, and potentially throughout therapy, to ensure that families are referred to appropriate support networks.

Contribution to the Manuscript

Judy Schoeman conceptualized the study. Judy Schoeman, a PhD student, designed the study, developed the Redcap database, chose the questionnaires, enrolled patients, collected data, cleaned the data, analyzed the data, and wrote the manuscript.

Mariana Kruger, Elena Ladas, and Paul Rogers assisted with the design of the study and critically reviewed the manuscript.

Ilde-Marié Kellerman, Ronelle Uys, Gita Naidu, Biance Rowe, Jan du Plessis, Mariechen Herholdt, Karla Thomas, Barry Vanemmenis, Rema Mathews, Ané Büchner, Fareed Omar and David Reynders were investigators at the different sites, enrolled patients, collected data and critically reviewed the manuscript.

Sandile Ndlovu assisted with this nested study's statistical design, analyzed the Poverty Assessment Tool data, and critically reviewed the manuscript. Carl Lombard did the statistical analysis of the hunger scale questionnaire and critically reviewed the manuscript.

List of abbreviations

BMI	= Body mass index
BMI/A or BAZ	= Body mass index for age
CI	= Confidence interval
CSG	= Child Support Grant
HAZ	= Height for age
MUAC	= Mid-upper arm circumference
MUAC/A	= Mid-upper arm circumference for age
OS	= Overall survival
POUs	= Pediatric oncology units
RRR	= Relative risk ratio
US$	= United States of America dollar unit

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Conflict of Interest

The authors have no conflict of interest to report.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author, JS. The data are not publicly available due to data containing information that could compromise the privacy of research participants.

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