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Research

Prevalence and determinants of malnutrition in children with cerebral palsy aged 6-59 months in rehabilitation centers in Kampala, Uganda

Mary I. Nanfuka[1,*], Benbella Dektar[2], Fred W. Mangen[3], Nelson Mukiza[4], Susan K. Nakazibwe[5], Emmanuel O. Ejuu[1]

[1]Department of Community Health and Behavioral Sciences-Makerere University School of Public Health, Kampala, Uganda; [2]Department of Health Policy Planning and Management, Makerere University School of Public Health, Kampala, Uganda; [3]Department of Epidemiology and Biostatistics-Makerere University School of Public Health, Kampala, Uganda; [4]Rinecynth Advisory Consultancy, Kampala, Uganda; [5]American Public Health Association, Washington, D.C., USA

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Background

In Uganda, a critical health concern emerges with Cerebral Palsy (CP), affecting approximately 2.7 per 1000 children. Anecdotal evidence suggests a strong correlation between CP and the heightened risk of malnutrition with its subsequent complications in children below five years. However, the extent of malnutrition prevalence and the determinants contributing to this condition among CP-afflicted children in Uganda's rehabilitation centers remain largely unexplored.

Objective

This study aimed to ascertain the prevalence of malnutrition and identify its determinants in a sample of Ugandan children aged 6-59 months attending Out Patient Department (OPD) and diagnosed with CP at selected rehabilitation centers.

Methods

Anthropometric measurements were taken on 168 children. Using the WHO Growth Chart as a benchmark, the study delineated malnutrition as a dependent variable using height-for-age, weight-for-height, and weight-for-age with a standard deviation score of ⩽ -2.0. Mid Upper Arm Circumference (MUAC) was measured and 12.5cm used as the cut-off point for malnutrition. A bivariate analysis was performed, employing the chi-square test to estimate the determinants of malnutrition (independent variables), yielding P values as a measure of association within 95% confidence intervals, complemented by multivariable probit regression. Data analysis was conducted using STATA v.15, duly considering the survey design effects, including sampling weight.

Results

Over half (53.6%) of sample children were 12-35 months old, and 64.3% were male. Most of the caregivers 118 (70.2%), were impoverished (monthly income of less than 100,000/= ~ US $ 27) with their children (67.6%) suffering from malnutrition (MUAC<12.5). The prevalence of any other form of malnutrition stood at 62.5%, with wasting, stunting and underweight at 34.5%, 39.9% and 39.9%, respectively. Age was a significant determinant, with children between 12-35 months (P=0.013;) and those over 35 months (P=0.001) exhibiting increased susceptibility to malnutrition. Additionally, consumption of less than three food groups per day was associated with a substantially higher risk of malnutrition (P=0.055).

*Corresponding author: maryejuu14@gmail.com

Conclusions

In conclusion, we found a high prevalence of malnutrition among children aged 6-59 months with CP in Ugandan rehabilitation centers who were outpatients (seeking physical, occupational, cognitive, speech and language therapies on the days they are offered). Poverty was clearly highly prevalent in these families with most caregivers being women, often single mothers.

INTRODUCTION

Cerebral Palsy (CP) is a neurological affliction resulting from brain damage in the fetal developmental phase, and is the most common motor disability in childhood (Sadowska et al. 2020). Intellectual disability is an important and relatively common accompanying impairment in CP that has the potential to further affect daily activities, burden of care, quality of life, effectiveness of interventions, and longevity (Reid et al. 2018).

CP is characterized by complications such as oral motor dysfunction, which impedes the digestive system by causing a range of gastrointestinal symptoms and complications thereby elevating the risk of infections among these young individuals, complicating their ability to recover from illness, and in some instances, leading to mortality (Schulze 2022).

Feeding difficulties among children with CP play an important role in the pathogenesis of malnutrition (especially undernutrition) and growth failure (Karim et al. 2019), as a result of oral motor impairment which interferes with coordination of swallowing and gastroesophageal reflux, that may lead to aspiration of food into the trachea causing choking and vomiting thus, leading to inadequate food intake—affecting the quality of life and health of an individual with CP (Hollung et al. 2020).

Rehabilitation centers offering services to children with CP render various therapies like; physical, occupational, speech etc; which have greatly helped to improve mainly the muscle balance and coordination abilities to reveal maximum mobility (Rommer 2020). In Uganda, anecdotal evidence suggests that a majority of these children seeking services are malnourished.

The long-term consequences of malnutrition in this demographic extend into adulthood, sometimes manifesting as poor growth especially in cognitive functioning of the body (Mwene-Batu et al. 2020). Children in the 6-59 months age bracket are exceptionally susceptible due to their limited capacity to withstand health crises and food shortages, compounded by their dependence on caregivers (WHO 2020).

In high-income countries, malnutrition rates among children with CP have been found to be 7.9% in the US (Reyes et al. 2019) and 38.1% in Greece (Karagiozoglou et al. 2012). In Greece, severe impairment and caregiver-dependent feeding are significant contributors (Karagiozoglou et al. 2012). Low-and middle-income countries exhibit a higher prevalence of malnutrition among these children (Jahan et al. 2019). For instance, in Ghana, 65% of children under 59 months with CP were undernourished, predominantly due to feeding difficulties (Polack et al. 2018).

However, in these countries, there is little data on malnutrition and its determinants in children aged 6 to 59 months with CP, which hinders prevention efforts (Jahan, et al. 2019). The present study aimed to determine the prevalence of malnutrition and its associated determinants among children with CP within the 6 to 59-month age range receiving outpatient services in the rehabilitation centers in Uganda.

MATERIALS AND METHODS

This study employed a cross-sectional design, utilizing quantitative methods for data collection and analysis. It was conducted from August 2020 to January 2021. Data collection and recruitment of participants ran from August 6, 2020, through November 11, 2020.

Data collection coincided with the COVID-19 pandemic and associated lockdown measures implemented between March 2020 and February 2021. The pandemic presented several methodological challenges including restricted travel and enforced quarantine. To address these challenges, we recruited study participants and collected data during periods when lockdown measures were temporarily relaxed or lifted.

STUDY SITE AND SETTING

The study was conducted within three rehabilitation centers in Kampala, Uganda, each of which received at least 50 pediatrics diagnosed with CP per month who were seeking services and were interested in participating in the research.

1. Cerebral Palsy Clinic at Mulago National Referral Hospital: This clinic is directly affiliated with the hospital's specialized neurology department and reports the admission of an estimated fifty children with CP each month. The clinic operates within the framework of the national referral system, addressing complex CP cases referred from various regions.
2. Katalemwa Cheshire Home for Rehabilitation Services: This non-governmental organization, initiated in 1970, dedicates itself to providing comprehensive rehabilitation services for children and adolescents with disabilities. The center is renowned for its disability-centric approach and reports an intake of approximately 60 children with CP monthly.
3. Mukisa Foundation Uganda: Established in April 2006, Mukisa Foundation Uganda engages in both preventative measures and therapeutic interventions for families of children with disabilities within Uganda. The foundation is noteworthy for its focus on community-based support and admits at least 50 children with CP each month.

STUDY POPULATION

The sample consisted of children aged 6-59 months who had been formally diagnosed with CP by a qualified medical practitioner. A review of 2019 registries of rehabilitation centers revealed that on average 52 children under five years diagnosed with CP sought rehabilitation services on a

monthly basis from both Mulago Hospital CP clinic and Mukisa Foundation, whereas 64 received rehabilitation services at Katalemwa Cheshire Home (Ministry of Health, 2019; Mukisa Foundation Uganda Registry, 2019; Katalemwa Cheshire home registry, 2019). Based on this information, we decided to select study participants based on the typical monthly intake for the three participating institutions: 52 from Mulago Hospital, 64 from Katalemwa, and 52 from Mukisa Foundation. All children aged 6-59 months diagnosed with CP who fulfilled the inclusion criteria were included at each of the three sites until their quota was reached.

STUDY VARIABLES

Anthropometric measurements were taken, including weight, height, and age, and weight-for-height (as an indicator of wasting or acute malnutrition), height-for-age (as an indicator of stunting or chronic malnutrition), and weight-for-age (as an indicator of being underweight) were calculated. These measurements were conducted following the WHO guidelines for anthropometric assessment. Standard MUAC tapes were used to measure mid-upper arm circumference (MUAC), following standard guidelines (IFRC 2019).

Height/length boards of full measurement range with two extensions capable of measuring up to 204 cm were utilized to accurately capture length in children unable to stand still. Tibia length was used as a segmental measurement to estimate stature in children with skeletal contractures. This was measured from the superomedial edge of the tibia to the inferior edge of the medial malleolus using a flexible tape measure. The estimated stature(s) was calculated using the validated equation (S=(3.26 xTL)+30.8(+/-1.4) (Stevenson 1995), then plotted onto WHO standard growth charts. All measurements were recorded to the nearest 0.1cm.

We operationalized "malnutrition" as a composite measure, encompassing stunting, wasting, or being underweight, defined by Z scores less than -2 by the World Health Organization's (WHO) standard charts. (That is, in the definition used in this paper, a child is considered to have malnutrition if it is either moderately or severely underweight, stunted, or wasted.

We also identified a range of independent variables based on the adapted and modified UNICEF conceptual framework of malnutrition (IPC 2016), categorized into the following domains: demographic factors (encompassing the child's age and gender, caregiver's sex and age, residence, income, and cultural and religious beliefs); health-related factors -- dietary intake issues such as choking, poor sucking, or vomiting, and other health conditions -- diarrhea and acute respiratory infections within the preceding three weeks); and multiple care-related factors.

The care factors included food consumption, measured by the daily dietary intake frequency and dietary diversification over the previous 24 hours from each of the seven food groups recommended by WHO (WHO 2010) (1. Grains, roots and tubers, 2. Legumes and nuts, 3. Dairy products, 4. Flesh foods, 5. Eggs, 6. Vitamin A rich fruits and Vegetables, 7. Other fruits and vegetables). Dietary intake data were collected using a structured 24-hour dietary recall method, which captured all food and beverage consumption during the preceding 24-hour period, including meals, snacks, and beverages. Food intake adequacy was measured by asking the caregiver if the child often choked, sucked poorly, or vomited when eating food. A yes or no response indicated inadequate and adequate food intake, respectively. Access to food was measured by asking the caregiver's household food security questions, adopted from a household food insecurity access scale (Family Health Internation 360 2018). Quality of care was evaluated in terms of caregivers' knowledge, attitudes towards providing nutritional services, and experiences of stigma using a Likert scale rating system guide adapted from Emlen's quality of care guide (Emlen 2007). Care also included health service utilization, as well as water, sanitation, and hygiene (WASH) practices at home (including handwashing with soap, handling of food leftovers, and consumption of boiled water).

The level of Gross Motor Functional Classification System (GMFCs) of CP was categorized into five levels, focusing on "the ability to sit, the capability for movement and mobility, charting independence, and the use of adaptive technology" (Paulson and Vargus-Adams 2017). According to this study, the GMFC I-III and GMFC level IV-V were considered as less severe and severe CP, respectively. Data management and statistical analyses.

The anthropometric data were input into EpiData software, version 3.02, and subsequently transferred into STATA software, version 15, to perform univariate analyses. To determine the association between malnutrition and the independent variables, a bivariate analysis was performed, employing the chi-square test. The study modeled the outcome using a probit regression model. This approach was chosen because the outcome variable was binary (Malnourished vs. not malnourished). The probit model assumes that the cumulative distribution function of the standard normal distribution best describes the relationship between the predictors and the probability of the outcome. The variables used were informed by existing literature on malnutrition.

Based on prior studies, we selected factors that have been shown to influence malnutrition, including demographic characteristics, socio-economic status, and health-related behaviors. These variables were included in the model, and a backward elimination technique was used to refine the model, ensuring its parsimony while maintaining an adequate fit. Additional marginal effects were analyzed to interpret the impact of each predictor on the probability of malnutrition. Marginal effects provided insights into how changes in the predictor variables influenced the likelihood of the outcome, allowing for a more intuitive understanding of the model's results.

ETHICAL CONSIDERATIONS

The research was conducted in full accordance with the guidelines set forth in the Declaration of Helsinki. A thorough explanation of the potential risks and benefits associated with the study was provided to participants before obtaining their consent. Participants were informed that they could withdraw at any point during the research process. Written consent was obtained from all participants,

who were the child's caregivers. Personal identifiers of the respondents were replaced with unique identification numbers in the dataset.

Ethical approval and requisite permissions to conduct this study were obtained from the Higher Degrees, Research, and Ethics Committee (HDREC) of the School of Public Health at Makerere University College of Health Sciences. Additionally, requisite approvals were secured from the respective research ethics committees of Mulago National Referral Hospital, Katalemwa Cheshire Home, and the Mukisa Foundation. Documentation of these approvals is available from the authors.

RESULTS

The study achieved a 100% response rate, resulting in a final sample size of 168. The median age was 24 months. Additional sociodemographic and disease-specific characteristics of the sample are detailed in Table 1.

Table 1. Socio-demographic and disease characteristics of the sample children with cerebral palsy

Characteristics	Katalemwa Cherish Home (n=64) n (%)	Mukisa Foundation (n=52) n (%)	Mulago Cerebral Palsy Clinic (n=52) n (%)	Total (%)
Sex of child				
Male	42 (65.6)	33 (63.5)	33 (63.5)	108 (64.3)
Female	22 (34.4)	19 (36.5)	19 (36.5)	60 (35.7)
Age of the child (months)				
6-11	11 (17.2)	9 (17.3)	11 (21.2)	31 (18.5)
12-35	30 (46.9)	26 (50)	34 (65.4)	90 (53.6)
35-59	23 (35.9)	17 (32.7)	7 (13.5)	47 (28)
Religion				
Christian	44 (68.8)	40 (76.9)	39 (75)	123 (73.2)
Others	20 (31.3)	12 (23.1)	13 (25)	45 (26.8)
Oral sores				
No	62 (96.9)	51 (98.1)	50 (96.2)	163 (97)
Yes	2 (3.1)	1 (1.9)	2 (3.8)	5 (3)
Dental caries				
No	53 (82.8)	37 (71.2)	42 (80.8)	132 (78.6)
Yes	11 (17.2)	15 (28.8)	10 (19.2)	36 (21.4)
Severity of CP				
GMFCS[1] level 1	12 (18.8)	5 (9.6)	8 (15.4)	25 (14.9)
GMFCS level 2	8 (12.5)	9 (17.3)	7 (13.5)	24 (14.3)
GMFCS level 3	17 (26.6)	9 (17.3)	11 (21.2)	37 (22.0)
GMFCS level 4	11 (17.2)	11 (21.2)	11 (21.2)	33 (19.6)
GMFCS level 5	16 (25.0)	18 (34.6)	15 (28.9)	49 (29.2)
Diarrhea in the last 3 weeks				
No	46 (71.9)	40 (76.9)	41 (78.8)	127 (75.6)
Yes	18 (28.1)	12 (23.1)	11 (21.2)	41 (24.4)
Difficulty in breathing for the last 3 weeks				
No	34 (53.1)	26 (50)	27 (51.9)	87 (51.8)
Yes	30 (46.9)	26 (50)	25 (48.1)	81 (48.2)
Choking or vomiting when eating				
No	28 (43.8)	13 (25.0)	15 (28.9)	56 (33.3)
Yes	36 (56.3)	39 (75.0)	37 (71.2)	112 (66.7)

GMFCS: Gross Motor Function Classification System - a standardized system used to classify the gross motor function of children and youth with cerebral palsy based on their self-initiated movement abilities, with particular emphasis on sitting, walking, and wheeled mobility. The system comprises five levels, with Level I representing the highest level of motor function and Level V representing the most severe motor limitations.

As shown in Table 2, a total of 62.5% of sample children had malnutrition of at least one type. Additionally, four exhibited bilateral lower limb edema.

Next, we assessed whether significant associations existed between malnutrition and various predictors, as shown in Tables 3, 4, and 5. The chi-square results in Table 3 show that all the p-values were found to be greater than 0.05, indicating that none of the assessed relationships between the categorical variables and malnutrition were statistically significant.

The chi-square results in Table 4, which examine the health and dietary determinants of malnutrition among the sample children, also show that all p-values were found to be greater than 0.05.

Table 2. Anthropometric characteristics of the sample, including nutrition status of the children aged 6-59 months with cerebral palsy in Ugandan rehabilitation centers

Nutritional status	Male (n= 108) n (%)	Female (n= 60) n (%)	Total n (%)
Stunting (ht/age⩽-2Z)			
No	61 (56.5)	40 (66.7)	101 (60.1)
Yes	47 (43.5)	20 (33.3)	67 (39.9)
Underweight (wt/age⩽-2Z)			
No	63 (58.3)	38 (63.3)	101 (60.1)
Yes	45 (41.7)	22 (36.7)	67 (39.9)
Wasting (wt/ht⩽-2Z)			
No	68 (63.0)	42 (70.0)	110 (65.5)
Yes	40 (37.0)	18 (30.0)	58 (34.5)
Malnutrition (any one of the above three)			
No	36 (33.3)	27 (45.0)	63 (37.5)
Yes	72 (66.7)	33 (55.0)	105 (62.5)
Malnutrition based on MUAC			
Normal (MUAC ⩾ 12.5cm)	73 (67.6)	43 (71.7)	116 (69.1)
Moderate Acute Malnutrition (MAM)	15 (13.9)	11 (18.3)	26 (15.5)
Severe Acute Malnutrition (SAM)	20 (18.5)	6 (10)	26 (15.5)
Mean Z Scores	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Height-for-Age (HAZ)	-1.38 (3.51)	0.82 (13.15)	-0.59 (8.37)
Weight-for-Age (WAZ)	-1.51 (5.05)	0.21 (13.1)	-0.88 (8.89)
Weight-for-height (WHZ)	-0.07 (11.38)	0.32 (13.13)	0.07 (12.01)

Table 3. Bivariate analysis of socio-demographic determinants of malnutrition in sample children

Variable	Total	Normal n (%) (n=63)	Malnourished n (%) (n=105)	Pearson Chi^2 (df)	p value
Sex of child					
Male	108	36 (57.1)	72 (68.6)	2.200 (1)	0.134
Female	60	27 (42.9)	33 (31.4)		
Age of the child					
6-11months	31	16 (25.4)	15 (14.3)	3.8540 (2)	0.146
12-35months	90	33 (52.4)	57 (54.3)		
>35months	47	14 (22.2)	33 (31.4)		
Religion					
Christian	123	50 (79.4)	73 (69.5)	1.9446 (1)	0.163
Others	45	13 (20.6)	32 (30.5)		
Sex of caregiver					
Male	16	3 (4.8)	13 (12.4)	2.6526 (1)	0.103
Female	152	60 (95.2)	92 (87.6)		
Age of mother at child's birth					
⩽18years	24	8 (12.7)	16 (15.2)	0.2074 (1)	0.649
⩾18 years	144	55 (87.3)	89 (84.8)		
Marital status					
Married	90	33 (52.4)	57 (54.3)	0.0574 (1)	0.811
Not Married	78	30 (47.6)	48 (45.7)		
Region of residence					
Central	93	31 (49.2)	62 (59.1)		
Eastern	22	8 (12.7)	14 (13.3)		
Northern	14	8 (12.7)	6 (5.7)	3.2186 (4)	0.522
Western	29	12 (19.1)	17 (16.2)		
Southern	10	4 (6.4)	6 (5.7)		
Education level of caregiver					
Non-Formal	10	3 (4.8)	7 (6.7)		
Primary level	51	16 (25.4)	35 (33.3)	2.1166 (3)	0.549
Secondary level	74	32 (50.8)	42 (40.0)		
Tertiary level	33	12 (19.1)	21 (20.0)		
Distance of residence from health facility					
1-4km	40	18 (28.6)	22 (21.0)		
5-10km	78	28 (44.4)	50 (47.6)	1.3068 (2)	0.520
>10km	50	17 (27.0)	33 (31.4)		
Monthly income					
< 100,000	118	47 (74.6)	71 (67.6)		
100,000-200,000	24	7 (11.1)	17 (16.2)	1.0769 (2)	0.584
> 200,000	26	9 (14.3)	17 (16.2)		

Key: df – (degrees of freedom)

Table 4. Bivariable analysis of health and dietary determinants of malnutrition among sample children

Variable	Normal n (%) (n= 63)	Malnourished n (%) (n=105)	Pearson chi^2 (df)	p value
Food consumption				
adequate (n=131)	51 (81.0)	80 (76.2)		
Inadequate (n=37)	12 (19.1)	25 (23.8)	0.5199 (1)	0.471
Food groups consumed				
<3 food groups (n=48)	15 (23.8)	33 (31.4)	4.4648 (2)	0.107
3-4 food groups (n=79)	27 (42.9)	52 (49.5)		
>4 food groups (n=41)	21 (33.3)	20 (19.1)		
Disease				
Oral sores				
Yes (n=5)	2 (3.2)	3 (2.9)		
No (n=163)	61 (96.8)	102 (97.1)	0.0137 (1)	0.907
Dental caries				
Yes (n=36)	11 (17.5)	25 (23.8)	0.9428(1)	0.332
No (n=132)	52 (82.5)	80 (76.2)		
Severity of CP				
GMFCS Level 1(n=25)	10 (15.9)	15 (14.3)		
GMFCS Level 2 (n=24)	10 (15.9)	14 (13.3)		
GMFCS Level 3 (n=37)	16 (25.4)	21 (20.0)	1.7752(4)	0.777
GMFCS Level 4 (n=33)	12 (19.1)	21 (20.0)		
GMFCS Level 5 (n=49)	15 (23.8)	34 (32.4)		
Diarrhea in the last 2-3 weeks				
Yes(n=41)	13 (20.6)	28 (26.7)	0.7765(1)	0.378
No(n=127)	50 (79.4)	77 (73.3)		
Difficulty in breathing for the last 2-3				
weeks				
Yes (n=78)	26 (41.3)	55 (52.4)	1.9469(1)	0.163
No (n=86)	37 (58.7)	50 (47.6)		
Rehab. Center				
Katalemwa RC (n=64)	21 (33.3)	43 (41.0)		
Mukisa Foundation (n=52)	18 (28.6)	34 (32.4)	2.4462(2)	0.294
Mulago CP Clinic (n=52)	24 (38.1)	28 (26.7)		

Results in Table 5 shows only quality of care received by children was found to be significant (p=0.028).

Table 5. Bivariable analysis of care-related determinants of malnutrition among sample children

Variable	Total	Normal n (%) (n=63)	Malnourished n (%) (n= 105)	Pearson chi^2 (df)	p value
Access to Food (**Food security**)					
Secure (Reyes et al. 2019)	89	34 (54.0)	55 (52.4)	0.0398(1)	0.842
Not Secure (Wejnert et al. 2012)	79	29 (46.0)	50 (47.6)		
Child Care (**Quality of care**)					
Adequate (*Always ticked 5 times*)	91	41 (65.1)	50 (47.6)	4.8352(1)	**0.028**
Inadequate (*"never"* & *"sometimes" ticked 5 times* & *above*)	77	22 (34.9)	55 (52.4)		
Attitude towards Nutrition					
Positive attitude	97	36 (57.1)	61 (58.1)	0.0146(1)	0.904
Negative attitude	71	27 (42.9)	44 (41.9)		
Stigma					
No Stigma	141	52 (82.5)	89 (84.8)	0.1442(1)	0.704
Stigma	27	11 (17.5)	16 (15.2)		
Health Services (**Seeking Child Healthcare**)					
Sufficient	82	34 (54.0)	48 (45.7)	1.0736	0.300
Insufficient	86	29 (46.0)	57 (54.3)		
WASH Practices (**Use protected water sources**)					
Yes	125	49 (77.8)	76 (72.4)	0.6022	0.438
No	43	14 (22.2)	29 (27.6)		
Washing with soap at critical moments					
Yes	159	60 (95.2)	99 (94.3)	0.0704	0.791
No	9	3 (4.8)	6 (5.7)		
Cover pit latrine hole or toilet cover when not in use					
Yes	153	57 (90.5)	96 (91.4)	0.0439	0.834
No	15	6 (9.5)	9 (8.6)		

Table 6 provides a comprehensive overview of the variables included in the probit analysis investigating the predictors of malnutrition, detailing the dependent variable, the types of independent variables, and the base categories for categorical variables.

Table 6. Description of the variables used in the probit analysis

Variable	Type	Description	Reference Category
Dependent variable			
Malnutrition	Dummy (0/1)	Indicates presence (1) or absence (0) of malnutrition	N/A
Independent variables			
Gender	Dummy (0/1)	Female (0) or Male (1)	Female
Age category	Categorical	Age category for the children categorized as 6-11 mo, 12-35 mo, 35-39 mo	6-11 months
Oral sores	Dummy (0/1)	No oral sores (0) or presence of oral sores (1)	No-oral sores
Diarrhea	Dummy (0/1)	No diarrhea (0) or suffered diarrhea (1)	No diarrhea
Coughing	Dummy (0/1)	No coughing (0) or suffered from coughing (1)	No coughing
Choking	Dummy (0/1)	No choking (0) or suffered from choking (1)	No choking
GMFCs levels	Categorical	GMFCS levels categorized as Level 1, level 2, Level 3, Level 4, level 5	Level 1
Religion	Dummy (0/1)	Religion of the caretaker: Other religions (0) , Christian (1)	Other religion
Region of caretaker	Categorical	Region of the caretaker categorized as Central, Eastern, Northern, Western, Southern	Central Region
Education level of caretaker	Categorical	Education level of the caretaker categorized as non formal, primary, secondary, tertiary	Non formal
Distance to rehab center	Categorical	Distance in KM to the rehabilitation Centre categorized as 1-4 km, 5-10 km, > 10 km	1-4 km
Household income	Categorical	Household income categorized as <100,000, 100,000-200,000, > 200,000	< 100,000
Consumption of <than 3 food groups	Dummy (0/1)	Whether a child eats smaller meals No (0) or Yes (1)	No
Food security	Dummy (0/1)	Whether the household is food secure: No (0), Yes (1)	No
Total food groups eaten	Categorical	The categories of the number of food groups eaten categorized as < 3, 3-4, > 4	< 3
Sought health service	Dummy (0/1)	Whether the caretaker sought health service or not: No (0), Yes (1)	No
Quality care	Dummy (0/1)	Quality of care provided by the caretaker: Inadequate (0), Adequate (1)	Inadequate
Protected water	Dummy (0/1)	Use of protected water source: No (0), Yes (1)	No
Rehabilitation center	Categorical	Rehabilitation centre used, categorized as Katalemwa Cheshire Home, Mulago Cerebral palsy clinic, Mukisa Foundation	Katalemwa Cheshire Home

Table 7 shows the results from the probit regression. Log pseudo likelihood and Pseudo R2 were used to assess model fitness and explanatory power. The value of the log pseudo likelihood was -88.5, indicating a reasonable fit. The Pseudo R2b value was 0.204, suggesting that approximately 20.4% of the variability in malnutrition as a binary outcome was explained by the model. The prob > chi2 value was 0.0114, indicating the model was statistically significant. The variable that was found to be significant at 1% was age between 35-59 months, as compared to the base age of 6-12 months. The variables that were found to be significant at 5% were age of 12-35 months compared to the base age of 6-12 months; the Northern Region, as compared to the base of Central Region; distance of >10 km to the rehabilitation center, and the food security status of the family. Whether a child consumed <3 food groups per day due to scarcity and whether the caretaker sought health services were found to be significant at 10%. The actual effect of this variable is as explained in Table 8 regarding the marginal effect.

Table 7. Probit Model Regression Analysis

Variable	Coefficient	Std. error	Z	P value	95% Confidence interval	
Constant	-0.439	0.702	-0.63	0.532	-1.814	0.937
Gender	0.297	0.250	1.19	0.235	-0.193	0.786
Age category						
12-35	0.845	0.341	2.48	**0.013****	0.176	1.514
35-59	1.244	0.365	3.41	**0.001*****	0.529	1.960
Oral sores	-0.095	0.668	-0.14	0.886	-1.404	1.213
Diarrhea	0.396	0.303	1.31	0.191	-0.197	0.990
Coughing	0.265	0.252	1.05	0.292	-0.228	0.759
Choking	0.375	0.274	1.37	0.170	-0.161	0.911
GMFCs levels						
Level 2	0.152	0.417	0.37	0.715	-0.665	0.970
Level 3	-0.127	0.366	-0.35	0.728	-0.844	0.589
Level 4	0.241	0.407	0.59	0.553	-0.556	1.039
Level 5	0.030	0.365	0.08	0.935	-0.685	0.744
Religion	-0.305	0.278	-1.10	0.273	-0.850	0.240

Table 7. continue

Region of caretaker						
Eastern	0.005	0.342	0.01	0.988	-0.665	0.676
Northern	-0.935	0.416	-2.25	**0.025****	-1.750	-0.120
Western	-0.052	0.321	-0.16	0.871	-0.681	0.577
Southern	-0.318	0.500	-0.64	0.525	-1.298	0.663
Education level caretaker						
Primary	0.144	0.522	0.28	0.781	-0.879	1.169
Secondary	-0.094	0.513	-0.18	0.854	-1.099	0.911
Tertiary	0.496	0.571	0.87	0.385	-0.623	1.614
Distance to rehab center						
5-10 km	0.337	0.316	1.07	0.285	-0.282	0.957
> 10 Km	0.775	0.357	2.17	**0.030****	0.074	1.475
Household income						
100,000-200,000	0.219	0.367	0.60	0.551	-0.501	0.939
> 200,000	0.113	0.328	0.34	0.731	-0.530	0.755
Consumption of <than 3 food groups	0.540	0.281	1.92	**0.055***	-0.011	1.091
Food security	-0.583	0.277	-2.11	**0.035****	-1.125	-0.041
Total food groups eaten						
3-4	-0.032	0.303	-0.11	0.916	-0.626	0.562
>4	-0.558	0.386	-1.45	0.148	-1.314	0.198
Sought health service	-0.461	0.250	-1.85	**0.065***	-0.950	0.028
Quality care	-0.375	0.243	-1.54	0.123	-0.850	0.101
Protected water	-0.178	0.282	-0.63	0.528	-0.731	0.375
Rehabilitation Centre						
Mulago cerebral	-0.305	0.287	-1.06	0.287	-0.867	0.257
Mukisa	-0.054	0.325	-0.17	0.867	-0.691	0.582
Number of observations		168		Wald chi^2 (32)		52.94
Log pseudo likelihood[a]		-88.4858		Prob > chi^2		0.0114
Pseudo R^{22}		0.2039				

Key: *significant at 10%, **significant at 5%, ***significant at 1%

[a]In the probit analysis, the assessed model fit using the log pseudo likelihood, with a result of -88.4858, indicating a reasonable fit.

[b]The Pseudo R2 value from the Stata output was 0.2039, suggesting that approximately 20.39% of the variability in malnutrition as a binary outcome was explained by the model.

Table 8 presents the marginal effects, which illustrate how changes in each predictor impact the probability of a child experiencing malnutrition. The transition from the age category of 6-12 months to the age category of 12-35 months increases the probability of suffering from malnutrition by 26.1 percentage points (marginal effect = 0.261; p<0.01). The marginal effect of 0.261 for the age category of 12-35 months suggests that being in this category of age (as compared to those between 6-12 months) increases the probability of suffering from malnutrition by 26.1. Additionally, being in the age category of 35-59 months indicates a probability of almost 40 percentage points of suffering from malnutrition.

A caretaker living in the Northern Region shows a probability of a decrease of their child suffering from malnutrition by 28.9 percentage points as compared to living in the Central Region.

Distance of >10km to a rehabilitation center, as compared to a base of <4km, shows an increase in probability of suffering from malnutrition by 22.2 percentage points.

Consuming <than 3 food groups a day indicates a 16-percentage point increase in malnutrition probability. Conversely, being a food-secure household was associated with a 17.3 percentage point decrease in malnutrition probability. In addition, living in a household that sought health services compared to those that did not was associated with a 13.7 percentage point decrease in malnutrition probability.

Table 8. Average marginal effects (compared to the reference categories shown in Table 6)

Variable	Marginal effect	Std. error	Z	P value
Gender	0.088	0.073	1.21	0.227
Age category				
12-35	0.261	0.100	2.61	**0.009*****
35-59	0.370	0.099	3.73	**0.000*****
Oral sores	-0.028	0.198	-0.14	0.886
Diarrhea	0.117	0.089	1.32	0.185
Coughing	0.079	0.075	1.05	0.292
Choking	0.111	0.080	1.39	0.163
GMFCs levels				
Level 2	0.045	0.123	0.37	0.714
Level 3	-0.039	0.111	-0.35	0.728
Level 4	0.070	0.118	0.59	0.553
Level 5	0.009	0.109	0.08	0.935
Religion	-0.090	0.082	-1.11	0.269
Region of caretaker				

Table 8. continue

Eastern	0.001	0.100	0.01	0.988
Northern	-0.289	0.122	-2.36	**0.018****
Western	-0.015	0.095	-0.16	0.871
Southern	-0.097	0.155	-0.62	0.534
Education level caretaker				
Primary	0.043	0.157	0.27	0.784
Secondary	-0.029	0.155	-0.18	0.854
Tertiary	0.139	0.164	0.85	0.396
Distance to rehab center				
5-10 km	0.102	0.095	1.07	0.284
> 10 Km	0.222	0.098	2.27	**0.023****
Household income				
100,000-200,000	0.064	0.105	0.61	0.542
> 200,000	0.033	0.096	0.35	0.729
Consumption of <less than 3 food groups	0.160	0.081	1.99	**0.047****
Food security	-0.173	0.079	-2.18	**0.029****
Total food groups eaten				
3-4	-0.009	0.088	-0.11	0.916
>4	-0.172	0.118	-1.47	0.143
Sought health service	-0.137	0.073	-1.88	**0.060***
Quality of care	-0.111	0.072	-1.55	0.121
Protected water	-0.053	0.083	-0.63	0.526
Rehabilitation Centre				
Mulago Cerebral	-0.092	0.086	-1.06	0.289
Mukisa	-0.016	0.095	-0.17	0.867

Key: Asterisk (*) show the levels of significance. (*) shows significance at 10%, (**) shows significance at 5%, and (***) shows significance at 1%

DISCUSSION

Among children 6 to 59 months old with CP seeking rehabilitation services, 62.5% had malnutrition. This figure aligns closely with findings from Ghana, where 65% of children under 59 months with CP were malnourished (Adamu et al. 2018), but marginally less than the percentages observed in Kenya (70.3%) (Polack et al. 2018) and Nigeria (79.2%) (Koriata 2012). The heightened levels in these latter countries may be attributed to their inclusion of children receiving hospital care, where additional health complications can exacerbate nutritional deficits.

In contrast, the prevalence of malnutrition in children with CP attending rehabilitation centers in more affluent nations like Argentina, Greece, and the USA was found to be 52.9%, 38.1%, and 7.9%, respectively (Karagiozoglou et al. 2012, Koriata 2012, Reyes et al. 2019, Ruiz et al. 2020). Such disparities are likely income-related but may also partly be attributable to more advanced nutritional interventions in high-income countries, including gastrostomy and comprehensive access to nutritionists and therapists specializing in managing feeding difficulties in children with CP (Jahan et al. 2019).

We found a non-significant disparity among children with malnutrition at Katalemwa Cheshire Home (41%) and Mukisa Foundation (32.4%), compared to the Mulago Cerebral Palsy unit (26.7%). The latter, functioning under the auspices of the nation's premier referral hospital, Mulago, benefits from a comprehensive range of health services, including specialized nutritional support such as nutrition supplement donations to the children, nutrition counseling, etc. This advantage ostensibly accounts for the lower prevalence rate observed there. However, given the available nutritional interventions, this figure still exceeds expectations, suggesting that these services may be underutilized or ineffective.

Further, the study reveals that underweight (39.9%) and stunting (39.9%) are the predominant forms of malnutrition among children aged 6 to 59 months with CP in these centers. Interestingly, wasting (34.5%) is marginally less prevalent than stunting and underweight. This pattern mirrors findings from Ghana, where underweight was the most common nutritional deficit among children with CP under 59 months. However, the rates of wasting were notably higher (58%) compared to stunting (54%) (Polack et al. 2018). In most cases, wasting reflects recent weight loss, often due to acute illness, which requires urgent attention and nutritional therapy (Almuneef et al. 2019). Wasting being less prevalent in this study as compared to the findings in Ghana above, could be attributed to rehabilitation services and nutrition guidance both being offered in these centers, which was not the case for Ghana. Comparative studies, albeit limited in scope and differing in age brackets, have been conducted in more developed contexts, such as Turkey. These studies corroborate the prevalence of underweight as a primary concern among children with CP, affecting 13.2% of children aged 6 to 17 years (Tüzün et al. 2013).

It should be noted that children with CP often present with skeletal contractures, rendering height measurement challenging. Consequently, weight has become a more frequently recorded metric in these populations (Gage 2005). As such, underweight (weight-for-age) is endorsed as the principal indicator for monitoring fluctuations in undernutrition over time (Gage 2005).

Our study showed that children between one and five years old are more susceptible to malnutrition than their younger counterparts below one year old. This is similar to previous studies, which indicated that children in the 2–5 years age range have higher nutritional requirements and dietary needs for growth and development, which may not be adequately met due to feeding difficulties associated with CP as well as less care given to them as compared to their very young ones below one year (Zahra 2019) . Moreover, common nutritional deficiencies observed in children with CP, such as poor weight gain and inadequate intake of essential nutrients, can significantly impact their overall health

(Kakooza et al. 2015). Conversely, socioeconomic factors, including limited access to nutritious food and healthcare services, can further exacerbate the risk of malnutrition in this demographic (Munyumu et al. 2018).

This observation contrasts with the prevailing conditions in Kenya, where a distinct pattern of undernutrition prevails, primarily afflicting children below the age of two years, particularly in the form of wasting. Conversely, other research in Uganda suggests that the age bracket of over five years is associated with a higher incidence of malnutrition (Kakooza et al. 2015).

This phenomenon may be attributed to the rapid developmental milestones characteristic of the above one-year-old age group, rendering them particularly vulnerable to nutritional deficits. These preschool children are highly susceptible to malnutrition during this phase, necessitating increased care and attention (Zewdu and Halala Handiso 2020). In contrast, those below one year benefit from breastfeeding, either exclusively or partially, along with additional nutritious feeds, as they are predominantly homebound. Notably, children under two years in Kenya who experienced wasting may have been impacted by concurrent hospitalization, potentially exacerbating their nutritional challenges. Contrary to expectations, in this study, variables such as the child's sex, caregiver at the time of delivery, education level, and caregiver's income did not exhibit a significant correlation with malnutrition. This finding contrasts with Kenyan and Bangladeshi studies, where malnutrition is linked with lower household income and lower educational levels of caretakers (Koriata 2012, Jahan et al. 2019) However, it is plausible that the services offered by rehabilitation centers, including nutrition counseling and physical activities, played a pivotal role in ameliorating malnutrition in the context of this study. While economic interventions of this magnitude represent essential steps toward poverty reduction, comprehensive poverty alleviation requires multifaceted approaches addressing multiple socioeconomic determinants beyond direct financial support.

Recent findings elucidate a nuanced understanding of nutritional outcomes in children with CP. Contrary to previous assertions, this study observed that episodes of choking or regurgitation during feeding were not inextricably linked to malnutrition. This is a departure from prevalent scholarship, which ascribed malnutrition in children with CP to impediments in food intake precisely due to challenges in managing feeding-related complications (Maxwell 2011). Notably, regional studies have yielded mixed results: Kenyan research identified a correlation between choking or regurgitation and wasting, but not stunting (Koriata 2012), whereas Ghanaian studies have found an association between feeding difficulties and being underweight (Polack, Adams et al. 2018). In Zambia, it was reported that between 40 and 50 percent of undernourished children with CP faced feeding challenges (Simpamba 2017). The discrepancy in these findings from ours may be attributed to the enhanced care strategies employed at rehabilitation centers for outpatients in our study. These include optimally positioning children before meals to facilitate more effective chewing and swallowing, as well as allocating sufficient feeding time, which collectively contribute to better nutrition. Moreover, the enforced COVID intermittent lockdown period between March 2020 and February 2021 which encompassed our study period inadvertently provided caregivers with additional time to devote exclusively to the needs of these children.

Furthermore, our investigation corroborated the pivotal role of dietary diversity in the nutritional well-being of children aged 6 to 59 months with CP within rehabilitation centers. It was unequivocally established that the consumption of food per day comprising less than three food groups within 24 hours exhibited a significant association with malnutrition in this demographic. This could have resulted from food insecurity experienced in their homes. Such a diet falls short of WHO's recommended five food groups, including fruits, vegetables, legumes, nuts, and whole grains necessary for a balanced intake of macro- and micronutrients(Stacy 2016). However, there is a need for further research to explore the specific food groups consumed by children with CP aged 6 to 59 months.

In the examined pediatric sample, no correlation was detected between recent occurrences of diarrhea or acute respiratory infection (ARI) and malnutrition—a contrast to several studies suggesting a bidirectional relationship wherein undernutrition predisposes children to infection and vice versa (Giannattasio et al. 2016). ARI was observed to be a precursor to malnutrition elsewhere (Sarkar et al. 2013). The absence of such associations in this study may be attributed to the efficacy of health services within these rehabilitation centers, where early detection and prompt referrals for diarrhea and ARI mitigate potential nutritional detriments.

Moreover, other health complications, such as oral sores and diverse GMFCS levels in CP cases, showed no significant link to malnutrition. This may further underscore the centers' quality of care. Conversely, research in diverse global contexts—Argentina, Nepal, Kenya, and Uganda—indicates a rise in undernutrition with escalating GMFCS levels (Koriata 2012, Kakooza et al. 2015, Jahan et al. 2019, Ruiz et al. 2020), potentially reflecting the variance in community and clinical settings' approach to care, with an exception noted in Argentine centers, which might employ distinct methodologies in caring for these children.

According to the household food security information given by caregivers, this study reveals that a food-secure household was associated with a 17.3 percentage point decrease in malnutrition probability, highlighting the importance of food security to these households, agreeing with previous research (Frayne and McCordic 2018) emphasizing food insecurity as a key factor.

In a recent study, it was discovered that traditional health determinants such as access to healthcare, nutrition awareness, availability of clean water, handwashing before meal preparation, and proper sanitation practices like covering latrine holes were associated with malnutrition; surprisingly, these did not correlate with the prevalence of malnutrition among children aged 6-59 months with CP attending Ugandan rehabilitation centers apart from access to health care which was in agreement with the situation in Bangladesh, where lack of healthcare services is linked to significant malnutrition in this demographic (Karim et al. 2019), and echoes broader research in low- and middle-income countries highlighting poverty-induced barriers to

healthcare, clean water, and nutrition, which in turn escalate the risk of malnutrition (Banks et al. 2017).

The deviation in Ugandan findings may be attributed to the unique environment of rehabilitation centers such as the Mukisa Foundation, which offers complementary health services, health education, and subsidized care, encouraging guardians to utilize these services. Moreover, these centers facilitate referrals to specialized health institutions when necessary.

The importance of safe water, sanitation, and healthcare access in influencing the nutritional well-being of children with CP is well-established (Smith and Haddad 2015). Proper hygiene, sanitation, and safe drinking water are instrumental in reducing undernutrition and stunting by preventing infections that impair intestinal development (WorldVision 2022).

LIMITATIONS OF THE STUDY

The present study, conducted within rehabilitation facilities, presents a potentially skewed representation of Ugandan children aged 6 to 59 months who are diagnosed with CP. Such a context necessitates a cautious interpretation of the findings, acknowledging that the actual circumstances outside such settings may diverge from the study's reported outcomes. Moreover, it is recommended that subsequent inquiries expand their scope to encompass a multicenter approach, with a larger sample of children under five suffering from CP, to ascertain their nutritional status more accurately, including avoiding type 2 errors.

Although the Gross Motor Function Classification System (GMFCS) is recognized for its validity and reliability within clinical and research environments, it may be helpful to integrate alternative classification methodologies to obviate potential misclassification within the various CP categories.

The determination of height for children with physical impediments, such as contractures, may have been compromised, leading to less precise outcomes. To address this, tibia length was measured thrice, and an average height was calculated to minimize measurement error (Stevenson 1995).

CONCLUSION

In three of Uganda's rehabilitation centers, 62.5% of children aged 6-59 months with CP suffer from malnutrition, predominantly stunting (39.9%) and being underweight (39.9%). This issue is notably prevalent in those aged above one year, particularly when their diet on the previous day included fewer than three food groups. Addressing this requires targeted interventions by the Health Ministry and relevant stakeholders, focusing on children aged 6 to 59 months with CP to foster healthy development. Establishing more government-supported rehabilitation centers for special needs is essential. Additionally, creating information, education, and communication materials to enhance caregiver knowledge about CP and utilizing media to raise awareness about appropriate feeding practices and essential food groups is crucial for improving these children's nutritional status and growth. A broader, multicenter study is needed to comprehensively assess the nutritional state of children under five with CP. However, it must be noted that substantial improvement in children with CP in Uganda will require addressing the widespread poverty suffered by caregivers, who in our case were predominantly women, likely abandoned or lacking in substantial support from the children's fathers.

AUTHOR CONTRIBUTIONS

MIN: Conceptualization; writing – original draft, including methodology; resource mobilization; supervision of data collection; validating results; formal analysis; reviewing and editing. BD: data curation; Software; analysis of secondary data; designing the methodology; writing – review and editing; provision of resources; drafting the original manuscript and administrative support. FWM: Methodology; technical review; writing – review and editing. NM: statistical analysis of data. SKN: Conceptualization; data validation. EOE; Conceptualization; Writing – original draft; Writing – review and editing; provision and mobilization of resources. All authors have read and approved the final version of the paper and its submission for publication.

CONFLICT OF INTEREST

The authors declare that they have no other potential conflicts of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN SCIENTIFIC WRITING

Nothing to disclose.

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