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Original Article

Risk Factors for Malnutrition Among Children With Cerebral Palsy in Botswana

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ABSTRACT

BACKGROUND: Children with cerebral palsy in low-resource settings are at high risk of malnutrition, which further increases their risk of poor health outcomes. However, there are few available data on specific risk factors for malnutrition among children with cerebral palsy in the developing world. **METHODS:** We performed a case-control study among children with cerebral palsy receiving care at a tertiary care hospital in Gaborone, Botswana. Children with cerebral palsy and malnutrition were identified according to World Health Organization growth curves and compared with subjects with cerebral palsy without malnutrition. Risk factors for malnutrition were identified using multivariable logistic regression models. These risk factors were then used to generate a Malnutrition Risk Score, and Receiver Operating Characteristic curves were used to identify optimal cutoffs to identify subjects at high risk of malnutrition. **RESULTS:** We identified 61 children with cerebral palsy, 26 of whom (43%) met criteria for malnutrition. Nonambulatory status (odds ratio 13.8, 95% confidence interval [CI] 3.8-50.1, $P < 0.001$) and a composite measure of socioeconomic status (odds ratio 1.6, 95% CI 1.0-2.5, $P = 0.03$) were the strongest risk factors for malnutrition. A Malnutrition Risk Score was constructed based on these risk factors, and receiver operating characteristic curve analysis demonstrated excellent performance characteristics of this score (area under the curve 0.92, 95% CI 0.89-0.94). **CONCLUSIONS:** Malnutrition is common among children with cerebral palsy in Botswana, and a simple risk score may help identify children with the highest risk. Further studies are needed to validate this screening tool and to determine optimal nutritional interventions in this population.

Keywords: International child health, neurological disorders, cerebral palsy, Africa, malnutrition

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Introduction

Cerebral palsy is the most common pediatric motor disability worldwide.[1] Children with cerebral palsy are at an increased risk of malnutrition, even in high-resource settings,[2] and this risk is likely to be higher in low-resource settings.[3] In children with cerebral palsy, malnutrition increases the risk of adverse social, cognitive, and health outcomes, including risk of mortality.[4-6] Addressing food insecurity remains a challenge in many developing countries,[7] leaving children with disabilities particularly vulnerable to malnutrition and its associated consequences.

Cerebral palsy can facilitate malnutrition through multiple mechanisms.[8] Children with cerebral palsy often have difficulty feeding,[9] and approximately one third require assisted feeding.[10] In low-resource settings, this problem may be compounded by the lack of assisted feeding technologies and feeding support from trained therapists and families facing food insecurity may have greater challenges supporting the nutritional needs of children with disabilities.[3,9] Although screening tests for the risk of malnutrition among adults[11-13] and children[14-17] have been previously developed and validated, there is no existing tool to screen for malnutrition risk among children with cerebral palsy in low-resource settings.

Botswana is an upper-middle-income country in Southern Africa in which both malnutrition and cerebral palsy are significant burdens on the health care system. In a prior study, we noted very high rates of malnutrition among children with cerebral palsy in Botswana.[18] The current study is a retrospective case-control study to identify the major risk factors for malnutrition in children with cerebral palsy. We developed a simple screening tool to identify children at the highest risk of becoming malnourished in this population. We hypothesized that disease severity and socioeconomic status (SES) would be significant risk factors for malnutrition among children with cerebral palsy. The goal of this study was to develop methods for identifying children at the highest risk of malnutrition, so that those subjects could be targeted for future nutritional interventions.

Methods

Study design and setting

The study was conducted among children with cerebral palsy who were two to 15 years of age and receiving care at Princess Marina Hospital in Gaborone, Botswana, from 2013 to 2015. The cohort for this analysis was taken from a larger prospective study of cerebral palsy in Botswana. We conducted a case-control analysis of the subset of subjects from the larger cohort who had cerebral palsy and had complete nutrition data available. Details of the parent study, including inclusion and exclusion criteria, have previously been published.[17] In summary, subjects with cerebral palsy were recruited from outpatient clinics and inpatient wards, a diagnosis of cerebral palsy was confirmed according to standard criteria by a pediatric neurologist, and caregivers were approached for participation in the study. Subjects with human immunodeficiency virus (HIV) infection were excluded, as were patients with genetic or metabolic disorders, obstructive hydrocephalus, or primary neuromuscular disorders. Of note, feeding tubes were not widely available in Botswana during the period of this study, and no children with feeding tubes were enrolled.

Ethics statement

This study was approved by the Institutional Review Boards at the University of Botswana, Botswana Ministry of Health, and Princess Marina Hospital. Parents or caregivers of all subjects provided verbal and written informed consent to participate.

Case ascertainment and control population

Cases were children with cerebral palsy as per the aforementioned study inclusion criteria who also met criteria for moderate or severe malnutrition at the time of study enrollment and had longitudinal evidence of progressive weight loss or worsening of nutritional status over time. Control subjects were unmatched and included all available subjects from the source population with cerebral palsy, not meeting the study criteria for malnutrition.

We defined malnutrition according to standard World Health Organization (WHO) criteria for moderate malnutrition as two z-scores or more below the median of the WHO weight-for-age growth curve.[19] To prevent miscategorization of children with low muscle bulk due to cerebral palsy as malnourished, we additionally required that subjects crossed two or more WHO standard deviation curves between birth and study enrollment or had consistent weight loss recorded over two or more visits. Because single measurements of weight for age or weight for height have been shown to have poor sensitivity in detecting malnutrition in children with cerebral palsy,[20] identifying cases based on longitudinal growth patterns over time allows for more accurate identification of children who are chronically malnourished.[20]

Variables, data sources, and definitions

Key variables are presented in Table 1. Study personnel used caregiver interviews (in Setswana or English based on caregiver preference), chart review of inpatient and outpatient records, and standardized physical examinations as data sources. In Botswana, it is standard practice for caregivers or patients to carry outpatient medical records with them that include prior doctors' notes, medical histories, and standard WHO growth curves. Thus all children enrolled had outpatient records with standardized WHO growth curves available for review. Study data were collected on paper case report forms and entered into a password-protected, deidentified database. Missing data were handled with multiple imputation.

Cerebral palsy was defined according to the Bax et al. consensus definition as previously described.[21] Years of maternal education included primary and secondary schooling and years of postsecondary education. Disease severity was classified by the Gross Motor Function Classification System (GMFCS) according to published criteria[22] and was assigned by study author D.R.B. after review of all available information. Severity was further classified as "ambulatory" (GMFCS I-III) or "non-ambulatory" (GMFCS IV-V). Cognitive impairment was assessed using the International Cognitive Assessment as previously described,[18] and subjects were classified as having cognitive impairment if they performed greater than two standard deviations below age-adjusted norms or had cognitive impairment of such severity that they were unable to participate in formal cognitive testing. Food insecurity was defined as an affirmative answer to the question, "Does your family have any difficulty getting enough food?"

Statistical analysis

Statistical analyses were performed using Stata 12.1 (StataCorp LP, College Station, TX, USA). Descriptive statistics are reported, including medians and interquartile ranges for continuous variables and percentages for categorical variables. Comparisons between categorical variables were performed using a χ^2 test or Fisher's exact test. Comparisons between continuous variables were performed using the Kruskall-Wallis test because of non-normal distribution. Significance level was set at $P = 0.05$. Confounding was assessed in a multivariable logistic regression model by evaluating the association of each covariate with the exposure and the outcome. Covariates with a univariate $P < 0.20$ were evaluated in