# Correlates of Physical Activity among Young Children with Moderate Acute Malnutrition

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**Objective** To assess the levels of physical activity among young children with moderate acute malnutrition and to identify clinical, biochemical, anthropometric, and sociodemographic correlates of physical activity.

**Study design** In a cross-sectional study, 1609 children aged 6-23 months wore a triaxial accelerometer (ActiGraph GT3x+; ActiGraph, Pensacola, Florida) for 6 consecutive days, from which total physical activity were determined. Data on morbidity were collected based by history and physical examination, and serum C-reactive protein and $\alpha_1$-acid glycoprotein were measured.

**Results** A total of 1544 (96%) children had physical activity measured, of whom 1498 (97%) completed 6 consecutive days of physical activity recording with a daily median wear time of 24 hours. The mean (±SD) total physical activity was 707 (±180) vector magnitude counts per minute (cpm). Age was negatively correlated with physical activity; compared with children below 12 months of age, those 12-17 months of age, and 18-23 months of age had 51 (95% CI, 26; 75) and 106 (95% CI, 71; 141) cpm lower physical activity, respectively. Fever and malaria were associated with 49 (95% CI, 27; 70) and 44 (95% CI, 27; 61) cpm lower activity, respectively. Elevated serum C-reactive protein and $\alpha_1$-acid glycoprotein were both negative correlates of physical activity, and hemoglobin was a positive correlate.

**Conclusions** Physical activity declines with age in children with moderate acute malnutrition and is also inversely related to infection and inflammatory status. Future studies are needed to ascertain cause and effect of these associations. *(J Pediatr 2017;181:235-41).*

**Trial registration** Controlled-Trials.com: ISRCTN42569496.

Physical activity is now well established as important to both the current and future health of children and adolescents.[1] Higher levels of physical activity in childhood are associated with favorable metabolic and cardiovascular disease risk profiles,[2] increased well-being, and better cognitive and motor development.[3,4]

Studies using accelerometers have been conducted mainly in well-nourished children.[5-9] However, little is known about physical activity and their correlates among young children with acute malnutrition, a condition which is likely to affect health and developmental outcomes.[10] We are aware of 1 study using accelerometers in Ethiopian children admitted to hospital with severe acute malnutrition (SAM),[11] and studies using questionnaire or direct observation methods for children with moderate wasting in India and Mozambique.[12,13] No studies investigating physical activity and correlates using accelerometry are available in children with moderate acute malnutrition (MAM), defined as weight-for-height z score (WHZ) between -3 and -2 (World Health Organization [WHO] 2006),[14] and/or a midupper-arm circumference (MUAC) between 115 and 125 mm.[15]

We aimed to assess the level of accelerometer-based physical activity among 6- to 23-month-old children with MAM in Burkina Faso and to identify clinical, biochemical, anthropometric, and sociodemographic correlates of physical activity.

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| AGP | $\alpha_1$-acid glycoprotein |
| CRP | C-reactive protein |
| HAZ | Height-for-age z score |
| MAM | Moderate acute malnutrition |
| MUAC | Midupper-arm circumference |
| WHO | World Health Organization |
| WHZ | Weight-for-age z score |
| SAM | Severe acute malnutrition |

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## Methods

This is a cross-sectional analysis of baseline data from the TreatFOOD study (Controlled-Trials.com: ISRCTN42569496) among 1609 children with MAM. The activity measures were registered as a secondary outcome. The study was conducted in the Province du Passoré, Burkina Faso, at 5 local health centers (Gomponsom, Latoden, Bagaré, Bokin, and Samba) and a nongovernmental organization (Alliance for International Medical Action, Dakar, Senegal). Children were screened by community health workers using MUAC tapes or by designated screening teams with the use of both MUAC and WHZ. Furthermore, children could be referred to a study site from a health center or present at a site on a caretaker's initiative. The final assessment of study inclusion eligibility was performed at site. Children were enrolled if a diagnosis of MAM was confirmed, defined as WHZ between -3 and -2 (WHO 2006)[14] and/or MUAC between 115 and 125 mm.[15] In the study site, WHZ was determined using WHO field tables, but anthropometry was later recalculated before analysis. Children were not included if treated for SAM or hospitalized within the past 2 months, were participating in a nutritional program, required hospitalization, or had severe disability.

The study protocol was approved by the Ethics Committee for Health Research in Burkina Faso (2012-8-059), and consultative approval was obtained from the Danish National Committee on Biomedical Research Ethics (1208204). Consent was obtained verbally and in writing (signature or fingerprints) from caretakers of the children before inclusion.

The study was carried out in accordance with the declaration of Helsinki and international ethical guidelines for biomedical research involving human subjects, published by the Council for International Organizations of Medical Sciences. Medical treatment was provided according to an adapted version of the Integrated Management of Childhood Illness guidelines.[16]

### Sociodemographic, Clinical, Biochemical, and Anthropometric Data Collection

At enrollment, a nurse conducted a clinical examination and collected data using structured questionnaires for sociodemographic variables (number of people in the household, house ownership, fuel used in cooking, type of employment, child birth day) and breastfeeding status (breastfed or not on the day of enrollment). Fever was defined as axillary temperature ≥37.5°C. Upper and lower respiratory tract infections were diagnosed by experienced pediatric nurses based on an adapted version of the Integrated Management of Childhood Illness.[16] The morbidity data presented were collected at enrollment when initiating the activity measurement, and not repeated during the measurement period. Venous blood (2.5 mL) was collected to carry out rapid antigen test for *Plasmodium falciparum* malaria (SD Bioline, Malaria antigen P.f.), and to determine hemoglobin level (HB 301; HemoCue, Ängelholm, Sweden); anemia was defined as <11 g/dL. Serum was separated and stored at -20°C. C-reactive protein (CRP) and $\alpha_1$-acid glycoprotein (AGP) were determined using a simple sandwich enzyme-linked immunosorbent assay.[17] We defined CRP ≥10 mg/L and AGP ≥1 g/L as abnormal, indicating systemic inflammation. Weight (model 881; Seca, Hamburg, Germany) and length (wooden length board) were measured to the nearest 100 g and 1 mm, respectively. MUAC was measured to nearest 1 mm at the midpoint between the olecranon and the acromion process using a standard measuring tape. All measurements were done in duplicate. The anthropometry measurements were done by trained staff and equipment was checked daily. Standardization sessions were carried out prior to the start of the trial to ensure precision and accuracy of measurements. During the trial, anthropometry staff were closely supervised by the anthropometry team leader and the site supervisor. Movement ability of the children was defined as not able to crawl/walk, able to crawl, or able to walk as assessed by measurement staff based on observation using an adapted version of the Malawi Developmental Assessment Tool.[18]

### Physical Activity Measures and Questionnaire Data

Physical activity was measured objectively using a triaxial accelerometer (ActiGraph GT3X+; ActiGraph, Pensacola, Florida). The accelerometer was attached to an elastic belt placed on the skin at the right side of the hip and worn for 6 consecutive days (6 × 24 hours). Caretakers were instructed to only let enrolled children wear the device and to make sure that the accelerometer was placed on the right hip during the monitoring period. Monitors could be removed during bathing. We used data recorded by the device starting 7 hours after leaving the clinic and ending 7 hours before returning to the clinic to avoid recording unusual activity caused by the need to attend the clinical appointments. After monitor removal, the caregiver was interviewed using a structured physical activity questionnaire including perception and acceptability of the device, episodes of device removal, and whether children were carried and if so how many times per day (coded as never, 1-2 times per day, 3-6 times per day, more than one-half of the day, or all the day).

### Data Analyses

The recorded activity data were uploaded from the monitors using the Actilife 6 Software (ActiGraph). Raw accelerometer data were collected at a rate of 100 Hz. Data were integrated to 10-second epochs to permit detection of short bouts of activity.[6,19] Each axis (x, y, and z) was converted to counts per min (but still in 10-second resolution), following which vector magnitude was calculated as the square root of sum of the three squared count values. We included data from all times of the measurement period including night (and other sleep) time in the analysis, except the 7 hours in the beginning and end of the file (see above) and periods marked as nonwear. We defined nonwear time as continuous runs of zero activity ≥90 minutes. Days with <8 hours valid wear data and participants with <1 valid day of recording were excluded from the present analyses. We calculated total physical activity as mean vector magnitude over valid days (counts per minute, cpm).

All statistical analyses were performed using Stata v 12 (StataCorp, College Station, Texas). Anthropometric WHZ and