Clinical Nutrition

Nutritional status of children with clinical conditions

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SUMMARY

Background & aims: Nutritional status is an important consideration in many pediatric clinical conditions. This paper aimed to examine and compare the nutritional status, represented by body cell mass (BCM), of children with cancer, Crohn’s disease (CD), cystic fibrosis (CF) and anorexia nervosa (AN).

Methods:Anthropometry was measured and BCM was calculated from whole body potassium-40 counting in 259 children being treated for clinical conditions (n = 66 cancer; n = 59 AN; n = 75 CF; n = 59 CD) and 108 healthy children. BCM was adjusted for height (BCMI) and expressed as a Z-score relative to laboratory reference data.

Results: The CD (−0.80 ± 1.61; p = 0.0001) and AN (−1.13 ± 0.99; p = 0.0001) groups had significantly lower BMI Z-score than the healthy control (0.13 ± 0.75), cancer (0.50 ± 1.40) and CF groups (−0.09 ± 0.95). The cancer (−1.16 ± 1.60; p = 0.0001), CD (−1.13 ± 1.36; p = 0.0001) and AN (−0.97 ± 1.18; p = 0.0001) groups had significantly reduced BCM compared to the healthy control (0.07 ± 0.93) and CF group (0.31 ± 1.08). According to BCM Z-score, 42.4% of patients with cancer, 41.7% of the patients with CD, 27.1% of patients with AN, and 4.0% of patients with CF were considered malnourished.

Conclusions: This study demonstrates that children undergoing treatment for clinical conditions may have alterations in BCM, independent of BMI. Children with cancer, CD and AN all had a high prevalence of malnutrition. Assessment of body composition, not just body size, is vital to understand nutritional status in children with clinical conditions.

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1. Introduction

Nutritional status, represented by body composition, is an important consideration in pediatric clinical conditions as it can impact clinical outcomes factors such as infections, quality of life, long term comorbidities and survival [1–6]. To improve outcomes for pediatric patients, it is important to understand the impact that different conditions may have on nutritional status to allow malnutrition to be effectively treated or potentially prevented.

While anthropometry can provide a general indication of a child’s growth status or body size in relation to a reference population, body composition measures of both FM and components of FFM are more appropriate to understand nutritional status in children with clinical conditions.

Total body potassium counting is a body composition assessment method that measures the BCM. The BCM is the metabolically active component of the FFM and reflects the functional cellular components of the body involved in biochemical processes and energy metabolism [7]. Unlike the interpretation of total FFM, which can be affected by hydration changes with growth and disease [8–12], BCM is not influenced by hydration changes. Therefore, BCM measurements are an important reflection of nutritional status in growing children and those with clinical conditions.
Many studies have addressed the effect of clinical conditions on children's nutritional status [13–17]. However, these studies have used a variety of techniques to measure different components of body composition, which makes the direct comparison of nutritional status between clinical populations in these studies difficult. This current paper aimed to examine and compare the nutritional status of children with different etiologies, namely: cancer, CD, CF and AN.

2. Materials and methods

2.1. Subjects

Participants were children and adolescents between 5.00 and 17.99 years who were healthy Caucasian children or patients being treated for one of four clinical conditions; cancer, CD, CF or AN. All healthy children were recruited as part of a normative study and the children with clinical conditions were recruited for four separate condition specific research studies investigating the body composition of children with these clinical conditions. The patients were all currently being treated at the Royal Children’s Hospital, Brisbane, and were representative of the total population that were currently being treated at the hospital. Children under five were excluded from the study due to lack of laboratory BCM reference data under this age. Data from the children with cancer and children with CF were previously published [18–20]. The study protocols were approved by the University of Queensland Medical Research Committee and the Royal Children’s Hospital Ethics Committee. Informed written consent was obtained from the parents or guardian of the children involved who, in turn, gave assent to be involved in the study.

2.2. Measurements

All measurements were taken in the Body Composition Laboratory at the Royal Children’s Hospital. Body weight was measured to the nearest 0.05 kg using calibrated digital scales (Tanita BWB-600, Wedderburn Scales, Australia) and height was measured to the nearest 0.1 cm using a wall-mounted stadiometer (Holtain Instruments Ltd, Crymmych, UK). Weight, height and BMI Z-scores were calculated based on age and gender using the Centers for Disease Control and Prevention 2000 growth data [21].

2.3. Body cell mass measurements

Potassium is the primary intracellular cation, and as 98% of the body’s potassium is located within the BCM [22], it is possible to determine BCM from TBK analysis. The TBK analysis was performed using a shadow shield whole-body counter (Accuscan, Canberra Industries, MA, USA), which contains three sodium iodide crystal scintillation detectors arranged above a scanning bed. The crystals detect the 1.46 MeV gamma rays being emitted by the 40K found in the body. As a fixed proportion of the body’s potassium occurs as the isotope 40K, the TBK can be determined. There is no radiation dose involved in this method and it is considered a safe, simple and non-invasive measurement for use in children from birth.

The measurement of TBK required the subject to lie supine on a bed that is moved under the detectors. Two 1100sec scans were performed for each subject with all personal metallic objects having been removed. Background and sensitivity checks were completed daily and considered in each measurement. BCM was then calculated from TBK using the equation of Wang et al. [23,24];

$$BCM = \frac{(TBK)^{0.918}}{39.1}$$

The amount of BCM is related to height, with BCM increasing with height regardless of improving nutritional status, so when comparing between individuals and groups, it is vital to adjust for height using the gender specific BCM. The BCM was calculated, with height (m) being raised to the power of 2.5 for females (BCM/HT^{2.5}) and 3 for males (BCM/HT^{3}) [25]. BCM was expressed as a Z-score relative to laboratory reference data (mean n = 22 in each age group 5–18 years), with the LMS method used to create normal reference curves. A Z-score cut-off of BCM < -1.65 (representing below 5th percentile) was used to determine those individuals who were malnourished.

2.4. Statistical analysis

Mean and SD were used to describe the study sample. Independent t-tests were used to assess differences between genders within groups. Height, Z-score, weight Z-score, BMI Z-score and BCM Z-scores were compared between groups using one-way ANOVA and post-hoc Tukey HSD tests to adjust for multiple comparisons. Significance was set at p < 0.05 for all evaluations. Statistical analyses were performed using Statistical Package for the Social Sciences Version 22 (IBM SPSS Statistics 22.0).

3. Results

A total of 367 children and adolescents were involved in the study (n = 193 females) with a mean age of 12.2 ± 3.3 years. There were 108 healthy children (n = 53 females; 49%), 66 patients with cancer (n = 28 females; 42%), 59 patients with CD (n = 16 females; 27%), 75 children with CF (n = 37 females; 49%) and 59 females with AN; patient characteristics are shown in Table 1. In the cancer group, 65% had a hematological cancer and all were in active treatment phase, with 85% of patients less than two years since diagnosis. The mean time since diagnosis for the CD group was 1.33yrs, with 49% of the group less than six months since diagnosis. The mean PCDAI of the CD group was 20.3; 40% classified as in remission, 28% classified as mild disease, and 32% classified as moderate/severe disease. The mean lung function of the CF group was within normal limits (data not shown), but 94% of the group were pancreatic insufficient. Seventy-five percent of the females with AN were currently being treated as inpatients. There was no significant difference in the height, weight, BMI Z-score or BCM Z-scores between the males and females in the CD, CF and cancer groups, data not shown.

A one-way between groups analysis of variance was conducted to explore the impact of clinical condition on height Z-score, weight Z-score, BMI Z-score and BCM Z-scores (Table 2). There was a significant difference in height Z-scores for the groups: F (4, 1301) = 13.7, p = 0.0001. Post-hoc comparisons using Tukey HSD test indicated the cancer (−0.07 ± 1.04; p = 0.02), CD (−0.62 ± 0.90; p = 0.0001) and CF (−0.38 ± 1.12; p = 0.0001) groups were significantly shorter than the healthy controls (0.40 ± 0.86). There was a significant difference in weight Z-scores for the groups: F (4, 241) = 14.6, p = 0.0001. Post-hoc comparisons using Tukey HSD test indicated the cancer (−0.43 ± 1.06; p = 0.001), CD (−0.74 ± 1.61; p = 0.0001) and AN (−0.81 ± 0.91; p = 0.0001) groups were significantly lighter than the healthy controls (0.28 ± 0.80) and cancer groups (0.32 ± 1.40).

When BMI Z-scores were compared between groups, there was a significant difference in BMI Z-scores for the groups: F (4, 134) = 20.8, p = 0.0001. Post-hoc comparisons indicated the CD (−0.80 ± 1.61; p = 0.0001) and AN (−1.13 ± 0.99; p = 0.0001) groups had significantly smaller body size than the healthy control (0.13 ± 0.75), cancer (0.50 ± 1.40) and CF groups (−0.09 ± 0.95). When BCM Z-score was compared between groups, there was a
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