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Original Article

Body composition in childhood inflammatory bowel disease

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SUMMARY

Background & aims: Little is known about the impact of disease and treatment on the pattern of growth in children with Inflammatory Bowel Disease (IBD). Significant deficits in height and weight in children with Crohn's disease have been reported but changes in fat and fat free mass are less well defined. This study aims to describe the height, weight and body composition of a cohort of children with IBD.
Methods: Height, weight, skinfold thicknesses and bioelectrical impedance analysis was performed. Disease activity was assessed with clinical scoring systems.
Results: 55 children, median age 13.7 years (range 6.5–17.7) were studied. Median (25th, 75th percentile) Standard Deviation Score for BMI, Height and Weight were − 0.3 (− 0.97, 0.65), − 0.56 (− 1.42, 0.06), − 0.62 (− 1.43, 0.19). In Crohn's disease, using multiple regression analysis disease activity measured by PCDAI was significantly inversely related to fat free mass (β − 0.2, 95% CI −0.17, −0.03, p 0.005).
Conclusions: Children with IBD were both under and overweight. Nutritional deficits were more common in Crohn's disease. Fat free mass was related to disease activity in children with Crohn's disease regardless of changes in weight. Weight or BMI may mask deficits in lean tissue in the presence of normal or increased proportions of body fat.

1. Introduction

Approximately one quarter of patients with Inflammatory Bowel Disease (IBD), principally Crohn's disease and Ulcerative Colitis, present in childhood[1] typically during adolescence and run a chronic relapsing course. Linear growth failure is common at diagnosis, particularly in Crohn's disease and growth can falter before major gastrointestinal symptoms develop[2]; by the time they present to a clinician, two thirds of children with Crohn's disease are underweight.[1] The aetiology of the growth deficit in IBD is not well defined but likely to arise from an interaction between the inflammatory disease process, genetic predisposition and the extent to which the demands for energy and nutrients are met.[3] Thus the clinical management of these children must include appropriate nutritional support to facilitate disease remission and promote growth whilst controlling inflammation and minimising toxicity of treatment regimens.

Measurements of height and weight are routinely used in clinical practice to characterise the nutritional state of the child and usually expressed in terms of the degree of height deficit (shortness), weight deficit (underweight or lightness) or relative weight for height or BMI for age (thinness). Each component captures a different dimension of growth and whilst each is important, none in isolation is sufficient to adequately describe the nutritional state of the child. Comparisons of weight or BMI against age-related reference norms are complicated by the normal pattern of tissue accretion during puberty such that differences in measures of thinness (weight for height or BMI for age) can be driven by changes in lean and or fat. In children with IBD the pattern of tissue loss with disease, and accrual with treatment is unclear. Significant deficits in height and weight between children with Crohn's disease and healthy controls have been demonstrated,[3,4] some of which may be explained by delayed pubertal development.[4] A recent study highlights that BMI improves with treatment in children with Crohn's disease but Fat Free Mass Index (Fat Free Mass/Height^2) does not.[5] This raises the possibility that current treatment may not be adequate to sustain rates of lean tissue deposition seen in healthy reference children. This may have a significant impact on the long term health of children with IBD.

In this study we describe the body composition of children with IBD using a simple two compartment model of body composition derived from clinical methods available at the bedside.

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2. Methods

Patients were recruited from the regional paediatric gastroenterology service. All had Crohn's disease or Ulcerative Colitis, confirmed histologically according to international criteria[6] and treated following published guidelines.[7,8] Children aged less than 18 years, at any stage of disease activity, on any or no treatment, were included. Recruitment and study occurred from children attending outpatient clinics and those requiring inpatient stay between September 2007 and March 2008. All children were studied on one occasion in the morning following an overnight fast in association with measurement of resting energy expenditure.[9] Ethics approval was granted from the local research ethics committee.

2.1. Body composition

Height was measured with the head in the Frankfurt plane and weight was measured in light clothing after voiding; both measures were performed using validated equipment. Mid-upper arm circumference was measured. Skinfold thickness measurements at triceps, subscapular, biceps and suprailiac were taken in triplicate from the non-dominant side of the body using a skinfold calliper (Holtain Ltd. Crymych, UK) following the method of Tanner and Whitehouse[10] and fat mass calculated from the sum of skinfold thicknesses.[11–13] Fat free mass (FFM) was therefore the residual of weight and fat mass. Upper arm muscle area (UMA) was determined from triceps skinfold and mid-upper arm circumference.[14] In addition, bioelectrical impedance was also determined at 5, 50, 100 and 200 kHz and used to estimate Fat and Fat Free Mass (Quadscan 4000, Bodystat Ltd. Douglas, Isle of Man). The agreement (16) between the two approaches was high (r 0.94, $p < 0.001$) and so only the FM and FFM results by skinfold thickness are shown here. All measurements were made by a single observer (AW) except in one individual where a trained female observer took measurements for cultural reasons. Puberty was assessed based on the development of secondary sexual characteristics. Children were described as pre (Tanner stage 1), peri (Tanner stage 2–4) or post-pubertal (Tanner stage 5).[15]

2.2. Disease activity

Disease activity was scored using the Paediatric Crohn's Disease Activity Index (PCDAI)[16] for children with Crohn's disease and the Simple Colitis Activity Index (SCAI)[17] for those with ulcerative colitis. The PCDAI uses a combination of symptoms, growth and serological data to produce a disease activity score while the SCAI uses symptoms alone.

2.3. Statistics

Height, weight and BMI were converted to Standard Deviation Scores using the UK 1990 Growth standards by means of the LMS growth program (Harlow Healthcare, South Shields, UK www.healthforallchildren.co.uk). UMA and triceps skinfold Standard Deviation Scores were calculated from the National Health And Nutrition Examination Survey II dataset.[14] Fat Free Mass Index and Fat Mass Index were calculated (mass/height^2). There are no published references within the UK from which to calculate the Standard Deviation Score for FFMI and FMI. The effect of disease activity on weight, fat and lean mass was assessed using a linear regression model including age, height, gender and pubertal status (pre, peri or post). Data is quoted as median (25th and 75th percentile).

3. Results

55 children were studied. Median age was 13.7 years (range 6.5–17.7). 25 children were pre-pubertal, 10 mid way through puberty and 20 post-pubertal. 37 (67%) children had Crohn's disease and 18 (33%) Ulcerative Colitis. 35 children were male, 26 in the Crohn's group (70%) and 9 in the UC group (50%). Table 1 shows body composition data of the whole cohort and subdivided by disease category, there were no significant gender differences in BMI, height and weight standard deviation scores. Fig. 1 has BMI SDS plotted against height SDS. This demonstrates that 10 children have significant growth deficits (Height or BMI ≤ -2 SDS); their individual characteristics are shown in Table 2.

Fat and Fat Free Mass Indices results are shown in Fig. 2. UMA SDS results, as a marker of fat free mass, were lower than the median value for the reference population. The median (25th, 75th centile) results for both boys and girls combined were as follows Crohn's disease 1.32 (− 1.81, − 0.51); UC − 0.59 (− 1.36, − 0.15). Combined data for triceps SDS, as a marker of fat mass were not lower than the median; Crohn's disease 0.04 (− 0.43, 0.69); UC 0.07 (− 0.64, 0.81). Fig. 3 demonstrates these results and also shows that there is marked gender difference amongst children with Crohn's disease with boys having the lowest median UMA SDS.

3.1. Relationship to disease activity

3.1.1. Crohn's disease

The median PCDAI of the children with Crohn's disease was 10 (range 0–60); 22 (59%) had PCDAI $\geq$ 10 (active disease).

After adjusting for age, height, gender and pubertal status, there was a significant relationship between Fat Free Mass and disease activity, measured by PCDAI, (standardised β − 0.2, p 0.005), in children with Crohn's disease. Results of the model are shown in Table 3. No such relationship existed for fat mass (β − 0.2, p 0.3) or total body weight (β − 0.2, p 0.04).

3.1.2. Ulcerative colitis

The number of patients with UC was too small to permit analysis using the multiple regression model described above.

4. Discussion

This study shows that children with IBD can be underweight or overweight.

There were more children than expected from a normal distribution with a height, weight or BMI below − 2 SDS (Fig. 1); 11%, 15% and 7% respectively. While some children were exceptionally thin and some exceptionally short, none were both. Four children fulfilled WHO criteria for malnutrition; three children moderately malnourished and one child severely malnourished.[18]. At the other end of the spectrum three children (5%), had a BMI SDS > 2. and so would be considered at increased risk of developing obesity and associated co-morbidities.[19] None of these had received steroids in

Table 1
Demographic and anthropometric data. Data expressed as Median (25th, 75th percentile).

	Combined Group $n = 55$	Crohn's Disease $n = 37$	Ulcerative Colitis $n = 18$
Age (years)	13.77 (11.53, 16.08)	14.72 (11.76, 16.32)	11.95 (9.88, 15.25)
Gender	35 Male	26 Male	9 Male
Height SDS	− 0.56(− 1.42,0.06)	− 0.65(− 1.47,−0.02)	− 0.20(− 1.3,0.31)
Weight SDS	− 0.62(− 1.43,0.19)	− 0.74(− 1.57,0.09)	− 0.33(− 1.14,1.21)
BMI SDS	− 0.30(− 0.97,0.65)	− 0.47(− 1.18,0.44)	− 0.23(− 0.45,1.01)