Clinical Nutrition 33 (2014) 528–532

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

Original article

Dietary intake in children and adolescents with cystic fibrosis

J.W. Woestenenk [a,*], S.J.A.M. Castelijns [b], C.K. van der Ent [c], R.H.J. Houwen [b]

[a] Internal Medicine and Dermatology, Dietetics and, Cystic Fibrosis Centre Utrecht, University Medical Centre Utrecht, Internal Address KH.01.419.0, P.O. Box 85500, 3508 GA Utrecht, The Netherlands
[b] Department of Paediatric Gastroenterology and, Cystic Fibrosis Centre Utrecht, University Medical Centre Utrecht, Internal Address KE.04.133.1, P.O. Box 85500, 3508 GA Utrecht, The Netherlands
[c] Department of Paediatric Pulmonology and, Cystic Fibrosis Centre Utrecht, University Medical Centre Utrecht, Internal address KH.01.419.0, P.O. Box 85500, 3508 GA Utrecht, The Netherlands

ARTICLE INFO

Article history:
Received 19 March 2013
Accepted 13 July 2013

Keywords:
Cystic fibrosis
Diet records
Nutrition therapy
Diet

SUMMARY

Background & aims: The recommendation for caloric intake in CF patients is to obtain intakes between 110 and 200% of the estimated average requirement (EAR) for age groups and gender, of which 35–40 energy% should be from fat. It is questionable whether the advice is met.
Methods: 1726 Completed 3-day dietary food records of 234 CF patients (111 girls) and 2860 completed two non-consecutive 24-h dietary assessments of healthy controls (1411 girls) were studied. The dietary intake in CF patients was compared with that of healthy controls by using independent sample *t* tests.
Results: Caloric intake in children with CF varied highly with age (88–127% EAR), which is below or in the lower range of the recommended 110–200% EAR. However the absolute caloric intake in CF children was significantly higher compared to controls at all ages. In addition, apart from boys aged 1–3 years, all CF children had a fat intake of 35 energy% or more. This fat intake was significantly higher than in controls, as was the consumption of saturated fat, the latter being well above 10% of the total energy intake.
Conclusion: Although CF patients generally do not meet the EAR recommendations, they had a significantly higher caloric intake than controls. Moreover fat intake in CF patients does generally meet recommendations, but this resulted in a considerable consumption of saturated fat; a reduction of the latter seems appropriate.

1. Introduction

Cystic fibrosis (CF) is a lethal genetic disorder, characterized by chronic pulmonary inflammation, resulting in a gradual decline in pulmonary function. Most patients are also pancreatic insufficient, giving intestinal malabsorption. Lung disease and nutritional status are tightly intertwined,[1] in which a good nutritional status contributes to an improved pulmonary function and survival.[2–4] Therefore, an intake between 110 and 200% of the gender- and age-specific estimated average requirement (EAR) is commonly advised[5,6] with an appropriate dietary protein intake, and 35–40% of the energy derived from dietary fat.[7] However studies in patients with CF indicate that the actual caloric intake is generally lower.[8–10] Nevertheless, two small studies suggest that, although below recommendations, patients with CF still had a higher intake than their healthy counterparts.[8,10] We therefore set out to record the dietary intake for macronutrients (calories, protein, fat and carbohydrates) in a large cohort of paediatric CF patients, and compare this with healthy controls.

2. Methods

2.1. Study population

A dynamic cohort of Dutch children (age 0 till 18, born between 1988 and 2012) with proven CF who had medical care in the University Medical Centre Utrecht, were studied retrospectively. All children had a positive sweat test and/or two CF mutations, combined with clinical signs of CF. Yearly, weight and height were measured during routine clinical care, and dietary data were collected through 3-day dietary food records in clinical stable patients. This database thus includes data of clinical parameters, dietary intake and demographic information of all children in CF-care at the University Medical Centre Utrecht, from 1988 up to August 2012. The study included children and adolescents aged 2 years and older, who had at least one completed 3-day dietary food

Abbreviations: EAR, estimated average requirements; En%, percentage of energy.
* Corresponding author. Tel.: +31 88 75 566 09; fax: +31 88 75 553 29.
E-mail address: j.w.woestenenk@umcutrecht.nl (J.W. Woestenenk).

0261-5614/$ – see front matter © 2013 Elsevier Ltd and European Society for Clinical Nutrition and Metabolism. All rights reserved.
http://dx.doi.org/10.1016/j.clnu.2013.07.011

record and were using pancreatic enzyme replacement therapy at time of reporting. All parents gave written informed consent for storage and analysis of data of their children. The study was performed according to the guidelines of the medical ethics board of the University Medical Centre Utrecht.

For controls, data of two Dutch National food consumption surveys among the healthy Dutch population, starting out at age 2[11,12] were used. These surveys included samples of Dutch children (age 2–18) selected from representative consumer panels. Caloric, protein, fat, saturated fat and carbohydrate intake, collected through either two non-consecutive 24-h dietary records (age 2–6) or two non-consecutive 24-h dietary recalls (age 7–18), and data on age, gender and ethnicity of children and adolescents till age 18 were extracted.

2.2. Weight and height assessment

Weight was measured with a digital weight balance, to the nearest 0.1 kg. Height was measured with a stadiometer to the nearest 0.5 cm (Holtain, Crymich, UK). Both were compared with reference values for Dutch children by converting them to z-scores weight-for-age, height-for-age and body-mass-index using specialized software (Growth analyser 4 RCT, 2010, Dutch Growth Foundation). For non-Dutch children, weight and height were compared to reference values for their nationality. Children with one Dutch parent were analysed using Dutch growth charts.

2.3. Dietary intake assessment

Yearly, all CF patients received written instruction on completing a 3-day dietary food record including a request to maintain the child's usual dietary intake. All food and beverages consumed were recorded in portion sizes or weights during 2 week days and 1 weekend day whenever possible. Where weights were not specified, portion size weights were obtained from reference data.[13] The food records were coded and analysed by registered dieticians, using the Dutch Food Composition Database.[14] The nutrient composition, expressed as average daily caloric intake along with the contribution from protein, dietary fat, saturated fat and carbohydrate, expressed as gram and as percentage of energy (En%), was calculated for each assessment. Moreover, protein intake was also expressed as gram/kilogram bodyweight/day. The children were first grouped into age cohorts for which the specific Dutch nutritional recommendations (EAR) are made: 1–3 year, 4–8 year, 9–13 year and 14–18 year respectively, and subdivided into female and male.[15] For those who completed more than one 3-day dietary food record during a specific age interval, a weighted average intake was calculated. As this customary grouping gave less detailed results we subsequently expressed intake for each age year and for each gender.

3. Statistics

Descriptive statistics of categorical variables of the enrolled children were examined. For children with CF, the average ± standard deviation of weight, height, and body-mass-index is presented. Age groups with less than 30 measurements were tested on normality. Children with CF and controls, both subdivided according to age group and to age year, were compared with respect to energy intake expressed as absolute caloric intake and %EAR, and absolute protein, fat, saturated fat and carbohydrate intake as well as their contribution to total caloric intake, by using independent sample *t* tests or Mann–Whitney test. Statistical analyses were performed by using the Statistical Package for the Social Sciences Computer Software (SPSS Inc. version 20, Chicago, IL). All values were considered significant at $p < 0.05$.

4. Results

4.1. Clinical characteristics

Data of 234 patients (111 girls; 47%) of whom 97% were Caucasian, were analysed. Overall, the average z-scores weight-for-age and height-for-age varied within the different age groups from −0.0 to −0.6 and from −0.2 to −1.0 respectively. Z-scores for body-mass-index varied between −0.3 and 0.4, in which the lower z-scores for both weight-for-age and height-for-age were reflected in relative better outcomes of the z-score body-mass-index (see supplemental Table 1a and 1b for details).

In the CF group a total 1726 3-day dietary food records were obtained. The control group consisted of 2860 healthy children (1411 girls; 49%) who all completed two 24-h dietary assessments.

4.2. Caloric intake

Tables 1a and 1b show data on the dietary intake of CF children and controls in the different age groups, for girls and boys respectively. The commonly recommended caloric intake of 120% EAR was

Table 1a
Dietary intake derived from 811 completed 3-day dietary food records of 111 girls with CF (age 2–18 year) and 1411 completed two non-consecutive 24-h dietary assessments of healthy control girls.

Age group	1–3 year			4–8 year			9–13 year			14–18 year		
	CF	Control	*p*	CF	Control	*p*	CF	Control	*p*	CF	Control	*p*
N	67	309		93	467		81	350		42	285	
Average age, year (±SD)	3.1 ± 0.4	3.0 ± 0.6	0.19	6.5 ± 1.0	6.3 ± 1.4	0.17	11.2 ± 0.8	11.6 ± 1.4	0.04	15.3 ± 0.6	16.0 ± 1.2	0.00
Dutch EAR kcal intake	1119			1548			2262			2476		
Kcal/day (±SD)	1419 ± 240	1282 ± 292	0.00	1848 ± 328	1602 ± 383	0.00	2265 ± 368	2038 ± 406	0.00	2480 ± 432	2057 ± 494	0.00
%EAR (±SD)	127 ± 21	115 ± 26	0.00	119 ± 21	104 ± 25	0.00	100 ± 16	90 ± 18	0.00	100 ± 17	83 ± 20	0.00
Protein, g/day (±SD)	45 ± 11	43 ± 11	0.17	59 ± 12	51 ± 15	0.00	75 ± 16	64 ± 18	0.00	89 ± 21	68 ± 18	0.00
Protein, g/kg weight (±SD)	3.1 ± 0.7	2.9 ± 0.8	0.15	2.7 ± 0.5	2.2 ± 0.6	0.00	2.1 ± 0.5	1.6 ± 0.5	0.00	1.7 ± 0.5	1.2 ± 0.5	0.00
Fat, g/day (±SD)	55 ± 13	42 ± 14	0.00	72 ± 15	57 ± 20	0.00	90 ± 19	77 ± 22	0.00	97 ± 27	77 ± 25	0.00
Saturated fat, g/day (±SD)	22 ± 7	16 ± 6	0.00	27 ± 9	22 ± 8	0.00	34 ± 10	29 ± 9	0.00	36 ± 14	29 ± 10	0.00
Carbohydrate, g/day (±SD)	185 ± 36	183 ± 44	0.80	240 ± 52	218 ± 52	0.00	289 ± 50	262 ± 58	0.00	313 ± 53	259 ± 68	0.00
%En protein (±SD)	13 ± 2	14 ± 2	0.01	13 ± 2	13 ± 3	0.63	14 ± 2	13 ± 3	0.07	15 ± 2	14 ± 3	0.05
%En fat (±SD)	35 ± 5	29 ± 6	0.00	35 ± 5	32 ± 6	0.00	36 ± 4	34 ± 6	0.02	35 ± 5	34 ± 6	0.20
%En saturated fat (±SD)	14 ± 4	11 ± 2	0.00	13 ± 4	12 ± 3	0.00	13 ± 3	13 ± 3	0.06	13 ± 3	13 ± 3	0.11
%En carbohydrate (±SD)	53 ± 6	58 ± 6	0.00	53 ± 5	56 ± 7	0.00	52 ± 5	52 ± 6	0.48	52 ± 6	51 ± 7	0.77

Kcal = kilocalorie EAR = estimated average requirement SD = standard deviation