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Dietary Intake, Nutritional Status and Well-being of Cancer Patients: a Prospective Study*

PETER F. BRUNING,† ROB J. EGGER,‡ ANK C. GOOSKENS,† RUUD J. J. HERMUS,‡ KARIN F. A. M. HULSHOF,‡ COR KISTEMAKER,† EVERDIEN H. KLEIN POELHUIS,† ANS KOBASHI-SCHOOT,† JAAP ODINK,‡ WIL H. P. SCHREURS,‡ and MICHEL WEDEL‡

†*The Netherlands Cancer Institute, Antoni van Leeuwenhoek Huis, Plesmanlaan* 121, 1066 *CX Amsterdam, The Netherlands and* ‡*Institute CIVO—Toxicology and Nutrition TNO, P.O. Box* 360, 3700 *AJ Zeist, The Netherlands*

Abstract—*Changes in dietary intake, nutritional status, body composition and well-being were studied in* 108 *cancer patients over a period of* 20 weeks. *The patients, constituting a group of elderly women with uterine cancer, a group of elderly men with urological cancer and a group of male and female patients of various ages with malignant lymphoma, were prospectively followed during and after aggressive treatment given with curative intent. Detailed information on the dietary intake was measured by a dietary history and cross-check method covering the* 2 months *prior to the onset of therapy and a* 48-*hr dietary record which was applied seven times during the observation period. The nutritional status was monitored by anthropometric measurements and laboratory assays in blood and urine. The patient's well-being was assessed by the use of standard performance scales by the observers and the application of patient's questionnaires concerning complaints, ability to self-care, mobility and daily activities. The main results are described here, indicating that:* (1) *most patients studied had a more than adequate diet during the* 2 months *preceding cancer therapy when compared to the Dutch Recommended Dietary Allowances;* (2) *the impact on dietary intake and nutritional status was relatively minor and generally transient; and* (3) *the treatment course was accompanied by distinct changes of well-being associated with, but not necessarily resulting from or leading to, changes of dietary intake.*

INTRODUCTION

Most cancer patients face nutritional problems sooner or later in the course of their disease.

During the last decade much attention has been focused on the definition and assessment of cancer malnourishment, its aetiology and its treatment. For the majority of patients, however, little has been gained for a number of reasons. Very few quantitative data have been adequately collected about the dietary intake of patients, categorized according to diagnosis and stage of disease, in particular those undergoing aggressive cancer therapy [1, 2]. Although accurate techniques have been used recently to measure changes in total-body nitrogen, potassium and water content [3, 4], these sophisticated methods can be applied only to relatively small patient populations at great expense. The value of more indirect methods to determine changes in body composition which are more widely applicable is still under debate. As to the aetiology of malnourishment in cancer patients, a number of major factors have been recognized [5]. Diminished dietary intake often seems to predominate as the result of taste abnormalities, anorexia, nausea or local obstruction of the alimentary tract. Altered nutritional requirements may exist because of the needs of the tumor itself, or its influence on the metabolism of the normal tissues of the host. Such factors are difficult to assess in the individual patient. Nutritional losses due to malabsorption, renal or enteral leakage of proteins and electrolytes occur in some patients. Increased needs may further result from complicating infections, hemorrhage, surgical and other forms of still unavoidable tissue damage from cancer therapy. Particularly, pelvic–abdominal irradiation and intensive combination chemotherapy have been suspected to endanger the nutritional status [6–13].

Malnourishment of the cancer patient has been demonstrated to be correlated with prognosis [14–16]. Efforts to treat or to prevent deterioration of the nutritional status have as yet yielded little or no improvement of patient survival or cancer treatment toxicity in prospective randomized trials. These trials, however, have mainly concerned short-term application of parenteral nutrition to

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small patient groups of varied composition, generally without adjustment of the nutritional support to established individual needs. The best results have been reported in patients whose cancers were treated successfully [17]. Improvements of the subjective well-being have been observed more frequently, the mechanisms involved being poorly understood.

The goal of our study was to obtain more insight into dietary intake and its possible consequences for nutritional status, and physical and mental fitness. To this purpose we have prospectively investigated three groups of cancer patients during and after aggressive treatment which was given with curative intent.

In this paper the design, methodology and main results of the study are described. More detailed methodology and results are presented elsewhere for each part of the study.

MATERIALS AND METHODS

Patients

One hundred and eight of 143 patients successively admitted in the Antoni van Leeuwenhoek-hospital of The Netherlands Cancer Institute from October 1981 to May 1983 completed the study. All patients had histologically verified cancer and belonged to one of three main groups: (1) women receiving external abdominal irradiation for uterine cancer of the cervix or endometrium (group UC); (2) men treated with external abdominal irradiation for inoperable cancer of the urinary bladder or the prostate (group UB+P); and (3) men and women treated with combined cytostatic therapy for malignant lymphoma (Hodgkin's disease or non-Hodgkin lymphoma) (group ML). A brief clinical summary of the patients, their mean age and stage of the disease are presented in Table 1.

Of the 143 patients who were asked to participate in the study, only 11 refused for various reasons. Of the 132 patients who gave their informed consent, 15 dropped out in the first week and nine in the fourth to sixth week, leaving 108 patients who completed the 5-month study.

Patients were treated on an outpatient basis, with short hospitalization periods only for four women receiving 1-day intracavitary brachytherapy, for cervix carcinoma in three and endometrial carcinoma in one.

Cancer therapy

For the three groups of patients the therapy was as follows.

1. Twenty-eight women with cancer of the uterus who had recently undergone uterus extirpation with bilateral salpingo-oophorectomy received postoperative radiotherapy to the small pelvis, via an anterior and posterior field of 16 × 12 cm^2. The duration of radiotherapy was 4 weeks. A dose of 40 Gy was given in 4 weeks, in 20 fractions, five times per week in ten patients, and the equivalent dose in 16 fractions, four times per week in 18 patients. In four patients (1/24 with corpus carcinoma and 3/4 with cervix carcinoma) an intracavitary radiation was applied for a booster dose to the scar in the top of the vagina.

The first examination of the present study was done just before the start of radiotherapy, after complete surgical healing.

2. Fifty-two men with cancer of the bladder (n = 32) or prostate (n = 20) received radical radiation treatment for their disease. The duration of radiotherapy for bladder cancer ranged from 4 to 6 weeks and from 9 to 10 weeks respectively, including an interval of 3 weeks for prostatic cancer. In 20 patients with bladder carcinoma 55–60 Gy in 5 weeks were given via a three-field set-up, sparing the rectum, and directed to the bladder only. In 16 patients this dose was given in 20 fractions, four times per week, and for four patients in 25 fractions, five times per week.

In 11 patients with bladder cancer a dose of 40 Gy was given in 4 weeks to the small pelvis via an anterior and posterior field, followed by a dose of

Table 1. Clinical summary of the patients

Group	n	Tumour type	Stage	Age in yr (mean ± S.D.)	Sex
UC	20	endometrial carcinoma	T_{1-3}	63 ± 7	all female
	4	cervical carcinoma			
UB + P	32	urinary bladder ca.	T_{1-3}	69 ± 7	all male
	20	prostate carcinoma	$T_{1,2}$		
ML	10	Hodgkin's disease	T_{2-4}	44 ± 16	50% male, 50% female
	18	non-Hodgkin's lymphoma			

20 Gy in 2 weeks via a three-field technique. In three of those cases the doses were given with five fractions weekly, in eight cases equivalent doses were given with four fractions weekly. One further patient received small pelvis irradiation via two fields, four fractions per week, to a dose of 46 Gy.

Twenty patients were treated for early prostatic carcinoma. In five cases a dose of 40 Gy was given to the small pelvis, in 20 fractions five times per week. In nine patients an equivalent dose was given in 4 weeks in 16 fractions four times per week. Via a three-field technique, sparing the rectum, the same dose was given in 20 fractions in four cases and in 16 fractions in two cases.

In all patients irradiation was resumed after a rest of 3 weeks. Via a three-field technique, the dose was increased to the equivalent of 65 Gy, following a two-field technique in the first part of the treatment, or to 70 Gy following a three-field technique, keeping the weekly amount of fractions as before. In one case only 37 Gy in 4 weeks and 16 fractions was given to the small pelvis.

3. The malignant lymphoma group consisted of 14 men and 14 women, comprising ten patients with Hodgkin's disease and 18 with non-Hodgkin lymphoma. All patients were treated throughout the 5-month observation period. Four patients with Hodgkin's disease received three monthly courses of MOPP* or ABVD chemotherapy, followed by a mantlefield radiation treatment to a dose of 35 Gy in 4 weeks, five times per week. The field included lymph node regions of both sides of the neck, axillae and mediastinum. Two patients with non-Hodgkin's lymphoma were treated with irradiation to the ring of Waldeyer and neck nodes 40 Gy in 4 weeks, five times per week, followed by monthly courses of cytostatic therapy (CVP). Two patients with highly aggressive tumors received a very intensive cytostatic treatment (ACVP) combined with radiation therapy to the areas with the largest lesions (in weeks 3–6) followed by radiation therapy to the cerebrum (in weeks 11–13 for one patient and in weeks 3–6 for the other patient; the latter patient died in week 17). The 20 other patients received only chemotherapy during the whole observation period (COAP, 1; MOPP, 4; ABVD, 2; CHVP, 2; CICS + Bleo-VCR, 5; CICS 6).

Methods

The *dietary intake* during the 2 months preceding the start of the study was assessed by one of the three dietician-investigators using a detailed dietary history and cross-check method [18] in the week prior to the onset of therapy. A prospective quantitative analysis of the nutritional intake was done by the application of a 48-hr dietary record seven times during the 5-month observation period. By a rotating schedule all days of the week were uniformly covered twice for each patient during the course of the observation. The three dieticians carefully instructed the patients and checked regularly with the patients in person if the records had been filled out properly. At this occasion the patient was also asked to fill out a questionnaire about his subjective taste and food preference for seven times. Household measures (spoons, cups, etc.) were checked at the patient's home. Dietary data were coded [19] and the amount of macro- and micronutrients consumed were calculated with the help of the computerized version [20] of the Dutch food composition table. A more detailed report is given elsewhere [Gooskens *et al.*, unpublished manuscript].

The *nutritional status* was assessed five times in each patient by anthropometric methods to determine body composition and by a number of laboratory tests. Anthropometrical measurements by three trained investigators included body weight, standing height, left mid-upper arm and maximal calf muscle circumference and four skinfold thicknesses with a Harpenden caliper. The measurements were performed according to Tanner *et al.* [21], except for the triceps skinfold thickness which was determined according to Durnin and Womersley [22]. The fat percentage of the body weight was calculated from the mean sum of the biceps, triceps, subscapular and suprailiac skin-fold thicknesses and Durnin and Womersley's linear regression equations for 16- to 71-yr-old males and females [22]. Lean body mass was derived from body weight and fat percentage (100 − fat%/100 × body wt). The presence of edema or abnormal effusions was noted. A more detailed report is given elsewhere [Egger *et al.*, unpublished manuscript].

The laboratory analysis of blood and urinary parameters included ESR, haemoglobin, haematocrit, counts of erythrocytes, leucocytes and subclasses, thrombocytes, concentrations of serum albumin and total protein, iron, total iron binding capacity (considered to be proportional to transferrin), creatinine, urea, uric acid, total cholesterol, HDL-cholesterol, tryptophan, sodium, potassium, calcium, inorganic phosphate, magnesium, zinc and assays for retinol binding protein (RBP), vitamins A, B_1, B_2, B_6, B_{12}, folic acid C, D_3 and E, urinary excretion of urea and 5-hydroxyindolacetic acid (5-HIAA) compared to the excretion of creatinine.

Blood was obtained by venapuncture using Venoject evacuated blood collection tubes.

*Abbreviations: CVP, cyclophosphamide, vincristine, prednisone; ACVP, adriamycin, cyclophosphamide, vincristine, prednisone; COAP, cyclophosphamide, vincristine, cytosine-arabinoside, prednisone; MOPP, nitrogen mustard, vincristine, procarbazine, prednisone; ABVD, adriamycin, bleomycin, vinblastine, dacarbazine; CHVP or CICS, cyclophosphamide, adriamycin, epipodotoxophylline VM-26, prednisone; Bleo, bleomycin; VCR, vincristine.

Urinary fractions were collected in polyethylene vessels and acidified with boric acid.

Part of the EDTA blood was treated with trichloroacetic acid for the vitamin C determination and the acid extract of the blood was frozen immediately.

After centrifugation of the EDTA blood the packed cells were used to prepare hemolysate. Samples were frozen and stored at −20°C. The methods of determination are indicated here only for the blood parameters for which results are given in the present article. A more elaborate discussion of the laboratory data will be published separately.

Serum albumin was determined colorimetrically with bromocresol green [23]. For the determination of serum iron and total iron binding capacity bathophenanthroline was used in a colorimetric assay [24]. The retinol binding protein (RBP) was measured by single radial immunodiffusion using LC-Partigen Retinol Binding Protein new immunodiffusion plates of Behring Werke AG (Marburg, F.R.G.) Folic acid was determined with the Simul TRAC Kit of Becton Dickinson Immunodiagnostics (Orangeburg, NY, U.S.A.).

After treatment of the EDTA blood with trichloracetic acid the total vitamin C was determined in the acid filtrate by a colorimetric method according to the revised method of Roe and Kuether [25].

For the vitamin B_1 status in hemolysate the transketolase activity (ETK) was measured by the method of Smeets *et al.* [26]. The ratio between ETK activity after saturation with thiamine pyrophosphate (TPP) and the basic activity was expressed as α-ETK.

For the vitamin B_2 status the glutathione reductase activity in hemolysate (EGR) was measured by the method of Tillotson and Baker [27]. The activation coefficient α-EGR was calculated as the ratio of EGR activity with and without saturation with flavin adenine dinucleotide (FAD). A more extensive account of the estimation of the nutritional status is given elsewhere [Schreurs *et al.*, unpublished observations].

Physical and mental fitness were assessed by application of a checklist of complaints to be filled out by the patient five times during the investigation. This checklist of complaints, which had been constructed from the results of a pilot study [28], contained 42 items, of which 36 represented complaints of a 'psychological' and a 'physique' nature, four items on self-care, mobility and task performance, one on the number of resting hours during day-time and one on activities. All questions had to be answered by a choice of one out of four possible answers referring to the preceding day. The questionnaire was administered by one of the two psychologist-investigators. The dietician and psychologist who took care of a particular patient also independently determined his performance score according to the Karnofsky [29] and to the WHO scales [30]. A more detailed report will be published elsewhere [Kobashi-Schoot *et al.*, unpublished manuscript].

Final interview

At the end of the 5-month observation period each patient was interviewed by the psychologist to learn about his motives to participate, his appreciation of the study, his subjective needs for nutritional advice during treatment and his willingness to spend extra money if dietary support would require so.

Study design

Patients were studied during 20 weeks. In the week preceding therapy (week 0) baseline measurements were taken. A timetable of the design is given in Table 2. The timing of the observations were chosen because most irradiated patients (groups UC and UB + P) were expected to develop symptoms by the fourth week of treatment, with an increase around the completion of radiotherapy (week 7) and a gradual recovery thereafter. For chemotherapy patients (group ML) the intervals generally implied observations shortly before another cycle was initiated. Food intake and preference data were collected more often to increase their significance.

Statistical methods

The main effects and interactions of the factors group and time of measurement were tested using analysis of variance. The method used was proposed by Rowell and Wolters [31] and Keen *et al.* [32] and involves an analysis of orthogonal polynomials of the measured variables over time. The more commonly used split-plot analysis is only valid when correlations between times of measurement are equal. However, in the present study observations which were more closely spaced in time were frequently found to be more correlated than observations which were more widely apart.

When the overall effects of time or group, or the time–group interaction, were statistically significant in the analysis of variance, differences between means were tested with the method of the least significant difference [33] using the pooled error variance from the split-plot analysis. Skewed variables were transformed by logarithms, outliers were removed from the data, missing values were estimated [34]. The distribution of the scores of psychological measurements were far from normal. The non-parametrical test of Friedman [35] was used to analyse changes over time, separately for each of the four groups. When the time effect was

Table 2. Timetable of the study

	Week*																		
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Introductory information	*																			
2 months dietary history + crosscheck	*																			
48-hr dietary record	*			*		*		*			*			*						*
Food preference questionnaire			*		*	*		*			*			*						*
Anthropometric measurements	*				*			*						*						*
Laboratory tests	*				*			*						*						*
Complaint checklist	*				*			*						*						*
Performance score	*				*			*						*						*
Final interview																				*

*Week 0 is the week preceding the onset of therapy.

significant in the two-way analysis of Friedman, differences between separate times of measurement were tested with Scheffé's test.

RESULTS

Only a selection of data from each part of the study will be described here. More elaborate results from the various parts and their possible interrelationships will be published separately.

Dietary intake

Data from the dietary history with cross-check over the 2 months *prior to treatment.* As shown in Table 3, the average daily energy intake varied from 7.8 MJ (1873 kcal) in group UC to 11.4 MJ (2739 kcal) in the men of group ML. The contributions of dietary proteins, fats, carbohydrates and alcohol are represented in the same table. The proportional energy contribution from the various macronutrients varied little between the groups. The average daily intake of calcium, iron, retinol, and vitamins B_1, B_2 and C is given in Table 4. Apparently the Dutch Recommended Dietary Allowances (DRDA) were met by most patients in all groups with the exception of iron intake by women.

Data from the 48-hr dietary records during or after treatment. The mean daily intake of energy during the observation period is given in Table 5.

In group UC the mean daily energy intake significantly increased from week 5 to week 19 (7.3 MJ/1739 kcal to 9.2 MJ/2210 kcal respectively). The percentage of women whose intake was less than 2/3 of the DRDA for women between 55 and 75 yr of age in sedentary occupations varied from 18 (week 5) to 0 (week 19). Only 11% of the patients in group UC fell below the lower than 2/3 of the DRDA criterion at two times of observation. In group UB + P the mean daily energy intake

Table 3. Daily energy intake (mean ± S.D.) over 2 months *prior to treatment and contributions of dietary protein, fat, carbohydrate and alcohol (%)*

	Group			
	UC	UB + P	ML male	ML female
n	28	50	14	13
Energy MJ	7.8 ± 2.4	10.8 ± 2.2	11.4 ± 2.9	8.6 ± 2.0
Carbohydrate (%)	44	43	45	47
Fat (%)	39	41	39	35
Protein (%)	15	13	13	13
Alcohol (%)	2	3	4	4

Table 4. Average daily intake (mean ± S.D.) of micronutrients over 2 months *prior to treatment (dietary history)*

	Group			
	UC	UB + P	ML male	ML female
n	28	50	14	13
Calcium (mg)	1116 ± 283	1277 ± 407	1374 ± 732	114 ± 438
Iron (mg)	11.6 ± 3.1	14.2 ± 3.8	14.5 ± 3.5	11.9 ± 2.3
Retinol* (mg)	0.97	1.23	1.19	1.00
Vitamin B_1 (mg)	0.93 ± 0.23	1.20 ± 0.47	1.34 ± 0.49	1.02 ± 0.50
Vitamin B_2 (mg)	1.70 ± 0.47	0.84 ± 0.73	2.01 ± 0.71	1.52 ± 0.76
Vitamin C* (mg)	105	132	117	110

*Geometric mean because of log-normal distribution.

*Table 5. Mean daily intake of energy (± S.D.) (*MJ*) during the* 20 weeks *observation period (dietary record)*

	Week						
	0	3	5	7	10	13	19
Group UC	8.2 ± 2.4	7.5 ± 2.1	7.3 ± 2.4	8.6 ± 2.6	8.1 ± 2.5	8.8 ± 2.2	9.2 ± 2.4
Group UB + P	10.8 ± 2.5	10.5 ± 3.1	9.8 ± 2.7	10.3 ± 2.9	10.3 ± 2.7	10.4 ± 2.5	10.0 ± 2.5
Group ML male	11.5 ± 3.5	12.1 ± 3.8	11.7 ± 3.4	11.7 ± 3.1	12.7 ± 4.2	12.0 ± 2.1	10.6 ± 2.0
Group ML female	7.6 ± 2.8	9.9 ± 2.0	10.0 ± 2.9	8.8 ± 3.0	9.4 ± 2.28	8.6 ± 2.2	9.7 ± 1.7

decreased significantly in week 5, remaining stable during the rest of the study. The percentage of men whose energy intake was less than 2/3 DRDA ranged from 0 (week 0) to 8 (weeks 3 and 7). In group ML the pattern of energy intake is somewhat different for the group as a whole and also different for the small male and female subgroups. Men had the highest intake in week 10. Their daily energy intake averaged 11.8 MJ (2800 kcal) during weeks 0, 3, 5 and 7, rose to 12.7 MJ (3030 kcal) in week 10 and decreased to 10.6 MJ (2530 kcal) in week 19. In women an increase was observed from 7.6 MJ (1820 kcal) in week 0 to 9.9 MJ (2361 kcal) in week 3, ranging from 8.6 MJ (2051 kcal) to 10.0 MJ (2393 kcal) thereafter. Most ML patients fulfilled the more than 2/3 DRDA criterion at any time during observation.

More than 90% of the diaries were filled out by the patient, often with help of the partner. In the remaining 10% somebody else, most often a close relative, helped to provide the patient's intake data. In groups U and UB + P 80% of the diaries were filled out immediately with eating or drinking. In group ML this was done by two-thirds of the patients. The remainder was filled out at the end of the day. More detailed descriptions of food consumption are published elsewhere [Gooskens *et al.*, unpublished observations].

Nutritional status

As shown in Table 3, *anthropometric measurements* and laboratory tests were taken before treatment (week 0), representing a baseline value, and in weeks 4, 7, 13 and 19. Changes of body weight and

Table 6. Changes in body composition (mean ± S.D.)

	Week				
	0	4	7	13	19
Group UC					
Body weight (kg)	70.4 ± 13.2	70.1 ± 12.6	69.8 ± 13.1	70.4 ± 12.6	71.2 ± 12.3
Lean body mass (kg)	43.0 ± 5.0	43.0 ± 5.0	43.2 ± 5.1	43.3 ± 5.0	44.0 ± 5.0
Group UB + P					
Body weight (kg)	74.4 ± 12.2	74.1 ± 12.3	73.7 ± 12.4	74.3 ± 12.6	74.7 ± 12.2
Lean body mass (kg)	54.2 ± 6.1	54.1 ± 6.2	53.9 ± 5.9	54.5 ± 6.1	54.9 ± 6.0
Group ML female					
Body weight (kg)	69.9 ± 13.1	70.5 ± 12.0	71.1 ± 12.2	71.8 ± 13.2	72.1 ± 13.5
Lean body mass (kg)	45.0 ± 5.1	45.2 ± 4.7	45.4 ± 4.8	45.6 ± 5.2	45.7 ± 5.2
Group ML male					
Body weight (kg)	74.1 ± 11.1	75.2 ± 11.5	76.4 ± 12.1	77.5 ± 12.0	77.9 ± 12.3
Lean body mass (kg)	58.9 ± 5.6	59.5 ± 5.9	60.0 ± 6.0	60.4 ± 6.0	60.2 ± 5.9

lean body mass are represented in Table 6. All patient groups showed a mean body weight which at the end of the 5-months observation was above that at the start of the investigation. After only slight decreases in body weight during irradiation, the patients in group UC and group UB + P regained base-line values by week 13. The lean body mass significantly increased towards week 19 in both patient groups, without a demonstrable significant change during treatment. Patients in group ML showed only increases in body weight during their observation, with significant increases of lean body mass in the males but no significant change of this parameter in females.

The *laboratory* test results of the determinations of iron, total iron binding capacity, albumin, retinol binding protein, vitamins α-ETK and α-EGR, vitamin C and folic acid in blood are given in Table 7. These data represent a selection from the many laboratory parameters which were monitored.

Physical and mental fitness

In the *complaint checklist* administered in weeks 0, 4, 7, 13 and 19 the patient was requested to express

Table 7. Results of determinations in blood (mean ± S.D.)

	Week				
	0	4	7	13	19
Group UC (n = 28)					
Iron (μmol/l)	14 ± 6	16 ± 7	14 ± 5	14 ± 6	16 ± 7
Total iron binding capacity (μmol/l)	57 ± 9	55 ± 8	59 ± 10	56 ± 9	57 ± 8
Albumin (g/l)	43.1 ± 2.6	42.3 ± 2.9	43.2 ± 3.1	43.9 ± 3.4	44.5 ± 5.8
Retinol binding protein (mg/l)	63 ± 16	58 ± 18	67 ± 16	69 ± 16	66 ± 9
α-ETK (u/u)	1.02 ± 0.18	1.07 ± 0.09	1.06 ± 0.10	1.09 ± 0.10	1.07 ± 0.07
α-EGR (u/u)	1.07 ± 0.17	1.08 ± 0.14	1.11 ± 0.13	1.11 ± 0.15	1.10 ± 0.13
Vitamin C (μmol/l)	54 ± 23	39 ± 20	43 ± 22	46 ± 18	42 ± 19
Folic acid (nmol/l)	8.1 ± 2.0	6.5 ± 1.9	7.6 ± 2.6	7.2 ± 2.2	8.1 ± 3.1
Group UB + P (n = 50)					
Iron (μmol/l)	14 ± 5	16 ± 6	14 ± 6	15 ± 6	16 ± 6
Total iron binding capacity (μmol/l)	58 ± 12	55 ± 9	55 ± 8	58 ± 13	56 ± 11
Albumin (g/l)	43.5 ± 2.6	42.4 ± 2.3	42.6 ± 2.6	43.1 ± 2.3	42.8 ± 2.8
Retinol binding protein (mg/l)	69 ± 17	67 ± 15	68 ± 16	69 ± 17	66 ± 14
α-ETK (u/u)	1.08 ± 0.07	1.08 ± 0.08	1.10 ± 0.07	1.09 ± 0.07	1.09 ± 0.06
α-EGR (u/u)	1.08 ± 0.15	1.09 ± 0.14	1.11 ± 0.17	1.14 ± 0.21	1.13 ± 0.21
Vitamin C (μmol/l)	43 ± 17	46 ± 21	41 ± 18	42 ± 18	42 ± 19
Folic acid (nmol/l)	7.7 ± 4.0	6.5 ± 2.9	7.3 ± 3.7	7.7 ± 3.3	8.2 ± 3.3
Group ML male (n = 11)					
Iron (μmol/l)	12 ± 12	19 ± 14	13 ± 8	16 ± 9	17 ± 10
Total (μmol/l)	57 ± 11	57 ± 12	51 ± 14	55 ± 9	57 ± 8
Albumin (g/l)	41.3 ± 3.4	44.3 ± 3.7	44.2 ± 3.3	43.1 ± 2.9	44.2 ± 2.9
Retinol binding protein (mg/l)	62 ± 22	68 ± 16	63 ± 13	65 ± 25	70 ± 22
Vitamin B_1 (u/u)	1.07 ± 0.07	1.07 ± 0.05	1.06 ± 0.07	1.10 ± 0.09	1.08 ± 0.04
Vitamin B_2 (u/u)	1.07 ± 0.10	1.08 ± 0.10	1.10 ± 0.16	1.12 ± 0.15	1.17 ± 0.23
Vitamin C (μmol/l)	46 ± 18	55 ± 14	43 ± 17	40 ± 9	40 ± 18
Folic acid (nmol/l)	8.3 ± 2.6	8.6 ± 3.6	6.6 ± 1.5	6.6 ± 1.6	6.5 ± 2.3
Group ML female (n = 13)					
Iron (μmol/l)	7 ± 4	15 ± 6	12 ± 5	13 ± 6	14 ± 9
Total iron binding capacity (μmol/l)	52 ± 10	54 ± 10	54 ± 9	54 ± 8	54 ± 8
Albumin (g/l)	41.4 ± 3.9	43.3 ± 2.3	43.1 ± 2.9	43.2 ± 2.8	42.8 ± 2.6
Retinol binding protein (mg/l)	44 ± 16	66 ± 14	59 ± 25	52 ± 21	57 ± 16
Vitamin B_1 (u/u)	1.07 ± 0.05	1.09 ± 0.13	1.05 ± 0.07	1.05 ± 0.04	1.07 ± 0.06
Vitamin B_2 (u/u)	1.15 ± 0.23	1.15 ± 0.24	1.10 ± 0.21	1.13 ± 0.15	1.10 ± 0.29
Vitamin C (μmol/l)	45 ± 19	48 ± 15	47 ± 18	48 ± 10	49 ± 18
Folic acid (nmol/l)	8.0 ± 3.7	7.7 ± 3.9	7.7 ± 3.0	7.3 ± 2.9	7.5 ± 2.0

his complaints on a 4-point scale as: "not at all" (0), "a little" (1), "quite a bit" (2) and "very much" (3). From the answers seven measures were analyzed, containing scales for malaise, physical fatigue, mental fatigue and psychological complaints. Only the results of the measurement of malaise are given here, as shown in Table 8.

As can be seen from Table 8, malaise scores given by the women of group UC were highest in week 4. For the men of group UB + P a similar pattern was observed, with scores being still high in week 7. The pattern in group ML was different, malaise scores rating highest before treatment, thereafter varying little and staying at approximately 2.0.

The numbers of resting hours during the daytime were asked together with the administration of the complaint checklist. It appeared that this parameter gave a pattern which was very similar to that of the scores on the malaise scale.

Performance scales. In order to compare the fitness data provided by the patient himself with the generally used performance scoring by medical personnel, the scores according to Karnofsky and the one adopted by the WHO were applied at the same times of observation as the complaint checklist by both one of two psychologist-investigators and one of three dietician-investigators independently. It appeared that the scores assigned by the psychologist and the dietician respectively were in close agreement, indicating the applicability of these parameters by personnel with no specific medical training. In Table 9 the psychologist's Karnofsky scores are shown.

Final interview

In a personal inverview by the psychologist in week 20 59% of the patients expressed their positive appreciation of the investigation in which they had participated. Of these, 5.7% gave a negative judgement and 35.2% answered in a neutral way. However, 86.7% of patients responded that they would advise other patients to participate in a similar study. The same 5.7% who had a negative experience would not do so, and 7.6% had no opinion. When asked about their motives to participate 72% of the patients expressed their hope that the results of the study would be beneficial to other patients, 23% felt some moral obligation and 5% gave various reasons. Only 17% of the study population indicated that they had given more attention than usual to dietary habits, 83% denying this. Correspondingly, only 13% expressed a need of nutritional advice during the preceding 5 months. On the other hand, 90% of the patients

*Table 8. Malaise scores**

	Week				
	0	4	7	13	19
Group UC (n = 28)	2.8	4.7†	2.1	1.4	1.5
Group UB + P (n = 50)	2.2	3.6‡	2.9‡	1.7	1.7
Group ML male (n = 14)	2.9	2.1	1.9	2.3	1.8
Group ML female (n = 14)	3.8	1.6	1.9	2.0	1.9

*The scores are the sum of scores on four items, each running from 0 (no complaint) to 3 (severe complaint).
†Significantly elevated compared to weeks 7, 13, 19 ($P < 0.01$).
‡Significantly elevated compared to weeks 13, 19 ($P < 0.01$).

Table 9.

	Week				
	0	4	7	13	19
Karnofsky index*					
Group UC	8.7 ± 1.2	8.0 ± 1.6	8.8 ± 1.2	9.5 ± 0.9	9.5 ± 0.7
Group UB + P	9.3 ± 1.0	8.6 ± 1.2	9.1 ± 0.9	9.4 ± 0.8	9.3 ± 1.0
Group ML (male)	8.5 ± 1.7	8.9 ± 0.6	9.1 ± 1.1	8.8 ± 2.0	7.8 ± 3.2
Group ML (female)	9.1 ± 0.9	9.2 ± 1.1	9.1 ± 1.0	9.1 ± 1.0	8.8 ± 1.0
ECOG score*					
Group UC	0.7 ± 0.5	1.1 ± 0.8	0.8 ± 0.8	0.3 ± 0.5	0.4 ± 0.5
Group UB + P	0.5 ± 0.6	1.0 ± 0.7	0.7 ± 0.8	0.4 ± 0.6	0.4 ± 0.5
Group ML (male)	0.9 ± 1.0	0.9 ± 0.5	0.5 ± 0.8	0.9 ± 1.4	0.9 ± 1.1
Group ML (female)	0.7 ± 0.8	0.5 ± 0.7	0.7 ± 0.9	0.5 ± 0.9	1.0 ± 0.8

*Mean ± S.D.

expressed their willingness to spend extra money if dietary advice would require so.

DISCUSSION

The present study was undertaken in an attempt to provide a quantitative estimate of the dietary intake, nutritional status and well-being of cancer patients undergoing treatment. Such prospective surveys have rarely been carried out [9, 11, 12, 36, 37]. In order to reach more general conclusions not only elderly patients undergoing intensive radiotherapy for cancer of the pelvic organs but also patients receiving prolonged combination chemotherapy for malignant lymphoma were included in the study. A broad set of parameters have been used for the nutritional assessment of 108 evaluable patients. The overall conclusion from the present results may be that even with the near maximal radiotherapy of the lower abdomen of elderly patients only a minor decrease of dietary intake has been observed. This change was generally transient and hardly reflected in changes of the nutritional status. The patients receiving prolonged intensive combination chemotherapy, to which in some of them radiotherapy was added, even showed an improvement of their energy intake, reflected by an increase of body weight. It should be emphasized that the nutritional condition of most patients was fair at the onset of the study, although this had not been used as a criterion of patient selection. Malnourished patients might not necessarily have done as well. Also, it should be mentioned that the results are described in terms of mean values and that the variance of these data is often considerable. Strikingly, most eligible cancer patients had an intake of energy, protein, vitamins and minerals which amply met the DRDA with an exception of the women with gynecological cancer, of whom 15 and 25% used less than 2/3 × DRDA of iron and retinol respectively. It is realized that these data may merely reflect the affluence of this country. The significant change of energy intake observed in the present study was accompanied by a corresponding change of body weight. The calculated lean body mass was stable or increased. However, the dietary intake of the cancer patient is just one complex of factors influencing body weight and composition. The finding that ML patients only gained body weight during therapy may be explained by their increased intake of major nutrients, their disease in general being successfully treated. The role of prednisone, which was part of the treatment of ML patients, seems complicated. Apart from improving appetite, corticoids are known to influence body composition, favoring the fat mass/lean body mass ratio, promoting the retention of sodium and water, but decreasing the body's potassium content. The interaction of corticoids with insulin may further complicate the picture, as it has been demonstrated recently with total parenteral nutrition in cancer-bearing patients that there is an optimal range of plasma insulin for the stimulation of whole-body protein synthesis and the decrease of skeletal muscle breakdown [38].

Of the laboratory parameters of nutritional status which were monitored and described above not one became abnormally low. Vitamin C levels decreased to some extent after the onset of therapy in the women with uterine cancer but still remained within the normal range. Folate levels decreased to some extent after week 4 in men, but not in women with malignant lymphoma.

Interestingly, the parameters of physical and mental fitness, taken together as well-being, revealed a rather distinct pattern which was related to the treatment period. Malaise and the amount of bed-rest needed during the day also showed a clear (inverse) relationship with dietary intake. Since well-being is determined by various factors and the present data do not allow conclusions as to which may have come first, diminished food intake or malaise, it is difficult to conclude to which extent malaise has contributed to a deterioration of the nutritional condition or vice versa. It may well be that both were similarly influenced by other factors such as treatment toxicity or the rate of tumor cell death.

Patient compliance with the elaborate investigation was good, as indicated by the very high percentage of patients who completed the diaries and various questionnaires. Cooperation with the monitoring of their nutritional status was excellent. Only 5–7% of the patients freely expressed during the final interview that, although they had been cooperative throughout the study, they would not advise other patients to do similarly.

The percentage of patients who expressed a need of nutritional advice during the foregoing 5 months period was surprisingly small. This could not be the result of advice which might have been provided by the hospital staff since this potential bias had been well avoided from the beginning. Although only 17% of the patients felt that they might have spent more attention to their dietary habits than usual, it is difficult to exclude the possibility that the observational study itself may have induced extra attention with the patients and those who cared for them.

From the present study of which only the main results have been described here, it is to be concluded that: (1) most patients studied had a more than adequate diet during the 2 months preceding cancer therapy when compared to the Dutch Recommended Dietary Allowances; (2) the impact on dietary intake and nutritional status of intensive

radiotherapy of the lower abdomen, which was given to cure mostly elderly people, and of intensive and prolonged combination chemotherapy administered to adults of various ages was relatively minor and generally transient; (3) the treatment course was accompanied by distinct changes of well-being associated with, but not necessarily resulting from or leading to, changes of dietary intake; (4) the results obtained do not seem to warrant a costly comparative study to investigate the effect of dietary intervention on nutritional status in similar patient groups; and (5) the connection between nutrition and well-being of cancer patients undergoing treatment should be further dissected.

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