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# NUTRITIONAL ASSESSMENT OF SELECTED PATIENTS WITH CANCER

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## ABSTRACT

**Background.** It is recognised that both nutritional status and an improper diet have significant effects on weakening the outcomes of treatment in cancer patients. As a result, a lowered response to therapy and an increase in untoward side effects is often observed leading to a deteriorating quality of life. The role of an adequately balanced diet is thus regarded as being vital in supporting recovery.

**Objective.** To assess the dietary consumption of calories, macro-elements and selected vitamins and minerals for subjects diagnosed with cancers of the breast, lungs and bones or soft tissue.

**Material and Methods.** A survey was performed on 100 subjects diagnosed with various tumours between the September and December months of 2011 consisting of 34 with breast cancer, 33 lung cancer and 33 with bone or soft tissue cancer. The questionnaire was devised in-house, which included a three day dietary record.

**Results.** The average daily calorific intake was found to be inadequate at 1608 kcal. In addition, abnormal proportions of energy derived from macro-elements was seen, where the contributions made by fats and proteins were somewhat high at respectively 35.1% and 16.5%, but too low in the case of carbohydrates at 52.1%. Up to 78% subjects had insufficient protein intakes, 88% showed deficiencies in consuming carbohydrates, as were 89% for fibre, 85% vitamin C, 99% calcium, 98% magnesium and 81% for iron.

**Conclusions.** Many dietary shortcomings were observed in the studied subjects. There is therefore a need to educate persons suffering from cancer to adopt an adequate and balanced diet as means of providing vital support for treatment to be more effective.

**Key words:** *cancer, nutritional assessment*

## STRESZCZENIE

**Wprowadzenie.** Nieprawidłowy sposób żywienia oraz stan odżywienia osób z chorobą nowotworową wpływa na słabszą odpowiedź na leczenie przeciwnowotworowe, może nasilać jego objawy uboczne oraz wpływać na jakość życia. Prawidłowo zbilansowana dieta pełni wspomagającą rolę w powrocie do zdrowia.

**Cel pracy.** Celem badań była ocena spożycia energii, makroskładników oraz wybranych witamin i składników mineralnych u osób z diagnozowaną chorobą nowotworową piersi, płuc oraz kości i tkanek miękkich.

**Materiał i metody.** Badanie przeprowadzono w okresie od września do grudnia 2011 roku. Badaną grupę stanowiło 100 osób ze zdiagnozowaną chorobą nowotworową (34 osoby z nowotworem piersi, 33 osoby z nowotworem płuc i 33 osoby z nowotworem kości i tkanek miękkich). Badania przeprowadzono przy użyciu autorskiej ankiety oraz metody 3-dniowego bieżącego notowania.

**Wyniki.** Spożycie energii przez osoby z chorobą nowotworową było niewystarczające i średnio wynosiło 1608 kcal/dzień. Procentowy udział poszczególnych makroskładników w dostarczaniu energii był nieprawidłowy, w przypadku tłuszczu i białka był zbyt wysoki (odpowiednio 35,1% oraz 16,5%), a w przypadku węglowodanów zbyt niski (52,1%). Aż 78% badanych nie realizowało normy na białko, w przypadku węglowodanów wartość ta wynosiła 88%, a dla błonnika 89%. Spożycie witaminy C było zbyt niskie u 85% badanych, wapnia u 99%, magnezu u 89%, a żelaza u 81% badanych.

**Wnioski.** W ocenianych racjach pokarmowych pacjentów obserwowano liczne nieprawidłowości. Istnieje potrzeba edukacji osób z chorobą nowotworową w zakresie zasad prawidłowego żywienia i znaczenia bilansowania diety.

**Słowa kluczowe:** *choroba nowotworowa, sposób żywienia*

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## INTRODUCTION

Epidemiological studies demonstrate that, after cardiovascular disease, cancer is the second most common disease contributing to mortality rates in Poland. This has constituted a serious problem for the elderly but now, more worryingly, for those aged under 65 years. Mortality rates show that in 2009, deaths from cancer amounted to 26% males and 23% females [8]. As has been well recognised for many years, the causes of malignant tumours are many and varied. It is estimated that 80 – 90% of such tumours arise from acquiring negative lifestyle behaviours that include smoking cigarettes, inappropriate diet, reduced physical activity, viral infection or long-term exposure to harmful factors from the environmental and/or work-place [33].

At the present time, some cancers can be successfully treated, however in Poland this amounts to barely 30% compared to 50 - 60% rates in Western Europe and the USA. Essentially, contemporary medicine offers 4 types of treatment; surgical intervention, chemotherapy, radiotherapy and immunotherapy [8].

Most cancer patients suffer from inadequate nutrition when the condition is diagnosed. One of the defining symptoms of developing malignant tumours, frequently observed, is a loss of body mass. Depending on the type of tumour, its location and stage of development, the body mass loss in cancer patients ranges between 30% - 80%. Accompanying symptoms are often seen which include body wasting, the cancer anorexia--cachexia syndrome, an aversion to eat, disturbances in body mass composition, and an abnormal metabolism coupled with a systemic inflammatory response. Indeed, the aforementioned syndrome is regarded as being one of the main factors that cause death in such cases. The abnormal nutritional status found in cancer patients is both a consequence of disease development as well as therapeutic interventions so administered, thus leading to a weaker response when anti-cancer treatment is used, more untoward side effects during therapy and a deteriorating quality of life that includes depression and decreased physical activity [18].

To gain a further understanding of how the nutritional component can affect cancer treatment, the study aim is to assess nutrition in patients suffering from this disease.

## MATERIAL AND METHODS

Study was conducted from September to December 2011 on 100 hospitalised patient subjects diagnosed with cancer which were divided into 3 groups according to type (Table 1). These consisted of 34 patients with breast cancer, 33 with lung cancer and 33 with bone and

Table 1. Characteristic of subjects

| Factor | Subjects | | | | p*** |
|---|---|---|---|---|---|
| | Total | type of cancer | | | |
| | | breast | lung | bone and soft tissue | |
| | n=100 | n=34 | n=33 | n=33 | |
| Gender | | | | | p=0.001 **** |
| women | 69 (69%) | 34 (100%) | 16 (49%) | 19 (58%) | |
| men | 31 (31%) | 0 (0%) | 17 (51%) | 14 (42%) | |
| Age (years) | $51.8 \pm 14.6$* | $53.3 \pm 12.0^{b}$ | $58.5 \pm 12.4^{b}$ | $43.4 \pm 15.4^{a}$ | p=0.001 **** |
| | 19 – 75** | 27 - 75 | 26 - 75 | 19 - 67 | |
| BMI ($kg/m^2$) | | | | | NS |
| | $26.0 \pm 4.85$* | $25.9 \pm 4.7$ | $27.2 \pm 4.3$ | $24.8 \pm 5.3$ | |
| | 16.3 –38.5** | 17.6 - 38.5 | 18.9 - 34.6 | 16.3 – 37.5 | |
| <18.5 | 6 (6%) | 1 (3%) | 0 (0%) | 5 (12%) | |
| 18.5-24.9 | 39 (39%) | 14 (41%) | 12 (36%) | 13 (39%) | |
| ≥25 | 55 (55%) | 19 (56%) | 21 (64%) | 15 (49%) | |
| Residence | | | | | NS |
| village | 21 (21%) | 6 (18%) | 7 (21%) | 8 (24%) | |
| town <25 tys. | 11 (11%) | 6 (18%) | 3 (9%) | 2 (6%) | |
| town 25-100 tys. | 29 (29%) | 8 (23%) | 10 (30%) | 11 (33%) | |
| town >100 tys. | 39 (39%) | 14 (41%) | 13 (40%) | 12 (37%) | |
| Education | | | | | NS |
| primary | 7 (7%) | 3 (9%) | 2 (6%) | 2 (6%) | |
| vocational | 16 (16%) | 4 (12%) | 7 (21%) | 5 (15%) | |
| secondary | 36 (36%) | 7 (21%) | 14 (43%) | 15 (46%) | |
| university degree | 41 (41%) | 20 (58%) | 10 (30%) | 11 (33%) | |

* mean ± standard deviation, ** range, *** *p* value for *Chi*$^2$ test (for age and BMI *p* value is result of *Kruskal-Wallis's* test), **** differences statistically significant (p ≤ 0,05), NS – differences are not statistically significant (p > 0,05)

soft tissue cancer. General information on gender, age, height, weight, place of residence and level of education were obtained by questionnaire. The Body Mass Index in kg/m$^2$ (BMI) was thus calculated. The patients were also graded according to BMI groupings using proposed WHO recommendations. A BMI < 18.5 was taken as underweight, 18.5 – 24.9 as normal and > 25 as overweight [34]. Expenditures of calories, macro-elements and selected vitamins and minerals were obtained on the day of patient admission to hospital, as part of continuing treatment using a 3 day current reporting procedure. In order to determine food portion sizes and menus consumed, a custom made photograph album of foodstuffs and dishes [29] was provided for patients so that appropriate selections could be made. The data so obtained was assessed by a computer programme tailored for this purpose [21], 'Foodstuff composition and nutritional value' from which individual estimates could be made for each of the aforementioned factors. Results were adjusted for technical and cooking (heat treatment) losses [31]. The body's daily calorific requirement was set at 35 kcal/kg body weight from which the proportions of energy obtained from protein, fat and carbohydrate were taken as 15%, 25% and 60% [9]. The levels had been established as being the nutritional requirements for normal healthy persons [15], taking into account individual patient's RDA, (Recommended Daily Allowance), and in the case of vitamins and minerals the AI (Adequate Intake). These were used because of the large risk of nutritional deficiencies occurring in cancer patients and also due to recommendations concerning fibre and cholesterol intake [15].

Table 2. Daily intake of energy and main nutrients

| Intake | Subjects | | | | p* |
|---|---|---|---|---|---|
| | total | type of cancer | | | |
| | | breast | lung | bone and soft tissue | |
| | n=100 | n=34 | n=33 | n=33 | |
| Energy [kcal/day] | 1608 ± 436[1]<br>669 – 3032[2]<br>1593[3] | 1439 ± 409[a]<br>669 - 2287<br>1439 | 1631 ± 448[b]<br>708 - 3032<br>1600 | 1754 ± 407[b]<br>1127 - 2563<br>1698 | 0.014<br>** |
| Energy intake below norm n (%) | 90 (90%) | 33 (97%) | 29 (88%) | 28 (85%) | NS |
| Protein [g/day] | 62.7 ± 15.1<br>25.4 - 107.7<br>60.3 | 59.4 ± 14.6<br>25.4 - 88.6<br>59.3 | 63.7 ± 15.7<br>29.9 - 107.7<br>60.2 | 65.1 ± 14.7<br>39.2 - 98.6<br>62.7 | NS |
| Protein intake below norm n (%) | 78 (78%) | 28 (82%) | 24 (73%) | 26 (79%) | NS |
| Fat [g/day] | 60.5 ± 18.9<br>24.3 - 127.1<br>60.5 | 53.4 ± 17.8[a]<br>24.3 - 89.7<br>50.3 | 61.0 ± 18.1[ab]<br>28.7 - 127.1<br>60.9 | 67.2 ± 18.6[b]<br>34.4 - 112.9<br>64.2 | 0.01<br>** |
| Fat intake below norm n (%) | 38 (38%) | 16 (47%) | 11 (33%) | 11 (33%) | NS |
| SFA [g/day] | 22.1 ± 8.2<br>5.6 - 51.5<br>21.2 | 18.4 ± 7.2[a]<br>5.6 - 33.7<br>17.3 | 22.3 ± 7.7[b]<br>12.3 - 51.5<br>22.6 | 25.6 ± 8.2[b]<br>10.4 - 46.4<br>24.3 | 0.001<br>** |
| PUFA [g/day] | 9.3 ± 3.6<br>2.7 - 24.9<br>8.8 | 9.1 ± 4.3<br>2.9 - 24.9<br>8.4 | 9.5 ± 4.0<br>2.7 - 19.4<br>9.0 | 9.2 ± 2.4<br>3.8 - 14.4<br>9.0 | NS |
| Cholesterol [mg/day] | 282 ± 140.5<br>60.1 - 682.0<br>245.0 | 240 ± 112.0<br>60.1 - 477.0<br>214.1 | 296 ± 139.4<br>83.4 - 625.0<br>275.7 | 311 ± 160.6<br>114.3 - 682.0<br>286.6 | NS |
| Cholesterol intake below recommendation n (%) | 62 (62%) | 25 (73%) | 18 (54%) | 19 (58%) | NS |
| Carbohydrate [g/day] | 203.1 ± 63.5<br>76.1 - 389.1<br>196.2 | 180.2 ± 59.3[a]<br>76.1 - 333.5<br>181.8 | 206.8 ± 66.0[ab]<br>91.1 - 389.1<br>201.4 | 222.2 ± 59.6[b]<br>138.9 - 351.3<br>208.7 | 0.02<br>** |
| Carbohydrate intake below norm n(%) | 88 (88%) | 33 (97%) | 28 (85%) | 27 (82%) | NS |
| Fibre [g/day] | 16.4 ± 5.5<br>5.9 - 34.7<br>15.7 | 15.4 ± 5.6<br>5.9 - 27.9<br>15.1 | 17.5 ± 6.0<br>6.0 - 34.7<br>17.1 | 16.4 ± 4.9<br>8.6 - 30.9<br>15.7 | NS |
| Fibre intake below recommendation n (%) | 89 (89%) | 31 (91%) | 28 (85%) | 30 (91%) | NS |

[1]mean±standard deviation, [2]range, [3]median, *value for *ANOVA* test or *Chi*$^2$ test, ** differences statistically significant ($p \leq 0.05$) marked with letters (a-b), NS- differences are not statistically significant ($p > 0.05$), SFA- saturated fatty acids, PUFA- polyunsaturated fatty acids

Statistical analyses used the Statistica Ver. 10 software. Normality was assessed by the *Shapiro-Wilk* test, where subsequent statistics were performed according to distribution type. The non-parametric *Kruskal-Wallis* test replaced *ANOVA* whenever normality was not observed. The $\chi 2$ test was used to compare frequency distributions and linear correlation was assessed by the *Pearson* test. In all cases P <0.05 was taken as the critical value for significance.

## RESULTS

Subjects had an average age of 51.8 ± 16.6 years, BMI of 26.0 ± 4.9 and the largest proportion (39%) lived in towns with greater than 100,000 inhabitants; the others consisting of 29% from towns with 25-100,000 inhabitants, 11% with < 25,000 and 21% from the countryside. Most had higher education at 41%, followed by 36% secondary education, technical schooling at 16% and basic/elementary education at 7% (Table 1).

Patients with the described forms of cancer had a lower average calorific consumption, at 1608 kcal/day (Table 2) compared to reference values, however this was not statistically significant. This was found to be most acute for those with breast cancer, where 97% had an insufficient dietary energy intake compared to 88% with lung cancer and 85% with bone and soft tissue cancer. Likewise, the distribution of energy sources were also found to be abnormal when sub-divided into dietary protein, fats and carbohydrates. For protein, these were higher than normal in patients with cancer of the breast by 16.7%, lung 16.4% and bone and soft tissue15.5% (Table 3); those with breast cancer were in fact significantly higher (p < 0.02) compared with the other forms of cancer. The proportion of calories derived from fats were too high in all 3 patient groups, an average 35.1%. There were no significant differences between any of the groups in the intake of carbohydrates, fibre, fat or cholesterol.

The proportion of patients with normal vitamin E intakes was statistically greater in those with cancer of the breast (62%) than lung (42%) and bone and soft tissue (34%) (Table 4). There were also significantly higher percentage of patients with bone and soft tissue cancer (82%) not serving the standard intake of vitamin PP, compared to those with breast (50%) or lung cancer (51%). No significant differences were however seen in the intake of vitamins A, C, B1, B2 and B6 compared to standards. A positive correlation was observed between vitamin A intake and the subject's education (r = 0.2, p ≤ 0.05). Of note, is the finding that vitamin A and B1 intakes were abnormal in almost 50% of the cancer patients; this being even higher for vitamin C at around 85%.

As well as for vitamins, the subjects showed abnormal intakes of minerals, especially calcium, magnesium and iron. In the former, overall intakes were insufficient at 502 mg/day (Table 5). Subjects with breast or lung cancer in fact all showed a deficient calcium intake and 97% of those suffering bone and soft tissue cancer. Magnesium intake was also deficient in 89% of all cases; those with lung cancer being the highest at 96%. Similarly for iron, 88% women with breast cancer had iron intake deficiency where the proportions for lung and bone/soft tissue cancers were respectively 79% and 76%. There were no significant differences between subject groups in the intake of calcium, potassium, magnesium, copper, iron or zinc. A positive correlation was observed between the intakes of potassium, magnesium, copper and iron with patient's education; r = 0.3, p ≤ 0.01 for iron and r =0.2, p ≤ 0.05 for the other elements.

## DISCUSSION

It is recognised that optimal body mass/weight should be maintained during oncological treatment and at its finish. Despite this, the occurrence of such patients being not only underweight, but overweight or obese is now becoming more frequently seen. Aggres-

Table. 3. The share of each macronutrient in providing energy

| Energy intake (%) | Subjects | | | | p* |
|---|---|---|---|---|---|
| | total | type of cancer | | | |
| | | breast | lung | bone and soft tissue | |
| | n=100 | n=34 | n=33 | n=33 | |
| Protein | 16.5 ± 2.4[1]<br>11.4 - 27.4[2]<br>16.1[3] | 17.6 ± 2.9[a]<br>13.6 - 27.4<br>16.7 | 16.4 ± 1.9[b]<br>13.9 - 20.2<br>16.4 | 15.5 ± 1.8[b]<br>11.4 - 19.6<br>15.5 | 0.02** |
| Fat | 35.1 ± 4.7<br>24.9 - 46.5<br>35.1 | 34.5 ± 4.7<br>24.9 - 42.7<br>34.7 | 35.1 ± 4.4<br>27.2 - 44.6<br>35.4 | 35.7 ± 5.0<br>27.4 - 46.5<br>34.0 | NS |
| Carbohydrate | 52.1 ± 5.5<br>35.3 - 64.1<br>52.2 | 51.6 ± 6.0<br>35.3 - 63.0<br>52.2 | 52.3 ± 5.1<br>43.6 - 64.1<br>51..5 | 52.4 ± 5.4<br>42.8 - 62.6<br>52.5 | NS |

[1]mean±standard deviation, [2]range, [3]median, * value for *ANOVA* test.
** differences statistically significant (p≤0.05) marked with letters (a-b), NS- differences are not statistically significant (p>0.05)

Table 4. Daily intake of selected vitamins

| Intake | Subjects | | | | p* |
|---|---|---|---|---|---|
| | total | type of cancer | | | |
| | | breast | lung | bone and soft tissue | |
| | n=100 | n=34 | n=33 | n=33 | |
| Witamin A [µg/day] | 859.8 ± 539.9[1]<br>128.6 - 3818.0[2]<br>694.1[3] | 816.8 ± 477.2<br>128.6 - 2384.0<br>667.2 | 926.9 ± 664.5<br>364.6 - 3818.0<br>762.9 | 835.8 ± 467.3<br>307.7 - 2566.1<br>687.7 | NS |
| Vitamin A intake below norm n (%) | 55 (55%) | 19 (56%) | 17 (51%) | 19 (58%) | NS |
| Witamin E [mg/day] | 8.8 ± 3.5<br>2.7 - 20.4<br>8.3 | 8.8 ± 3.6<br>2.7 - 16.7<br>8.7 | 8.8 ± 3.9<br>3.1 - 20.4<br>8.4 | 8.8 ± 3.2<br>3.9 - 18.4<br>7.8 | NS |
| Vitamin E intake below norm n (%) | 54 (54%) | 13 (38%)[A] | 19 (58%)[B] | 22 (66%)[B] | 0.05 |
| Witamin $B_1$ [mg/day] | 1.0 ± 0.4<br>0.3 - 2.1<br>1.0 | 1.0 ± 0.4<br>0.3 - 1.8<br>1.0 | 1.1 ± 0.4<br>0.5 - 2.1<br>0.9 | 1.0 ± 0.3<br>0.6 - 1.8<br>1.0 | NS |
| Vitamin $B_1$ intake below norm n (%) | 63 (63%) | 19 (55%) | 22 (67%) | 22 (67%) | NS |
| Vitamin $B_2$ [mg/day] | 1.2 ± 0.4<br>0.5 - 2.5<br>1.2 | 1.2 ± 0.4<br>0.5 - 1.9<br>1.2 | 1.2 ± 0.4<br>0.6 - 2.3<br>1.2 | 1.3 ± 0.5<br>0.5 - 2.5<br>1.2 | NS |
| Vitamin $B_2$ intake below norm n (%) | 44 (44%) | 15 (44%) | 16 (49%) | 13 (39%) | NS |
| Witamin $B_6$ [mg/day] | 1.7 ± 0.5<br>0.6 - 2.9<br>1.7 | 1.6 ± 0.5<br>0.6 - 2.7<br>1.6 | 1.8 ± 0.5<br>0.7 - 2.9<br>1.7 | 1.8 ± 0.4<br>1.1 - 2.7<br>1.8 | NS |
| Vitamin $B_6$ intake below norm n (%) | 26 (26%) | 11 (32%) | 11 (33%) | 4 (13%) | NS |
| Witamin PP [mg/day] | 13.6 ± 3.8<br>4.8-22.4<br>13.5 | 13.3 ± 4.3<br>4.8-22.1<br>13.8 | 14.3 ± 4.3<br>4.8-21.9<br>13.7 | 13.2 ± 2.8<br>7.8-22.4<br>13.1 | NS |
| Vitamin PP intake below norm n (%) | 61 (61%) | 17 (50%)[B] | 17 (51%)[B] | 27 (82%)[A] | 0.01<br>** |
| Witamin C [mg/day] | 51.7 ± 34.9<br>7.9 - 278.0<br>45.3 | 49.5 ± 33.6<br>7.9 - 152.9<br>44.1 | 54.6 ± 45.7<br>11.8 - 278.0<br>44.5 | 51.0 ± 22.1<br>12.4 - 106.5<br>46.1 | NS |
| Vitamin C intake below norm n (%) | 85 (85%) | 26 (76%) | 30 (91%) | 29 (88%) | NS |

[1]mean±standard deviation. [2]range, [3]median, *value for *ANOVA* test or *chi*$^2$ test, in the case of vitamin A, E and C value for *Kruskal-Wallis's* test. ** differences statistically significant (p≤0.05) marked with letters (a-b), NS- differences are not statistically significant (p>0.05)

sive anti-cancer therapy may both cause and deepen malnutrition but paradoxically lead to increased body weight. However patients suffering from cancer universally demonstrate a loss in body weight which is linked with a poor response to therapy and increased mortality risk. Such patients demonstrate both a loss of body fat and muscle [10]. A study by *Amaral* et al [1] showed 7.9% cancer patients to be underweight, 42.9% with a correct weight and 50.2% to be overweight or obese. Those underweight oncology patients, may be either due to the development of disease or a side-effect of therapeutic treatment, ie. chemotherapy, radiotherapy or surgical intervention. Patients undergoing general treatment exhibit symptoms of nausea, vomiting, diarrhoea, constipation, appetite loss, an aversion to particular foodstuffs, oesophageal inflammation and dysphagia. Patients also suffer from chronic stress and depression. It is not surprising that these symptoms may therefore lead to an insufficient dietary intake of calories and nutrients. *Kawai* et al [17] demonstrated that a low BMI in women with breast cancer is positively correlated with mortality risk, in contrast to such women that have a normal BMI. A study by *Kubrak* et al [20] observed that the decrease of BMI in patients with cancers in the head and neck was due the radiotherapy and chemotherapy treatment as well as increased CRP levels thus reflecting progressing states of inflammation and/or acute phase response. The decrease in BMI coupled with malnutrition has been shown by *Sanchez-Lara* et al [25] in lung cancer patients to be associated with decreased levels of HRQL (Health Related Quality of Life) which is an independent prognostic indicator of lung cancer.

Table 5. Daily intake of selected minerals

| Intake | Subjects | | | | p* |
|---|---|---|---|---|---|
| | total | type of cancer | | | |
| | | breast | lung | bone and soft tissue | |
| | n=100 | n=34 | n=33 | n=33 | |
| Calcium<br>[mg/day] | 502.0 ± 224.8[1]<br>114.6 - 1235.0[2]<br>452.4[3] | 455.6 ± 195.9<br>168.2 - 876.1<br>415.2 | 491 ± 188.6<br>179.4 - 1033.2<br>479.6 | 560.8 ± 274.2<br>114.6 - 1235.0<br>489.0 | NS |
| Calcium intake below norm n (%) | 99 (99%) | 34 (100%) | 33 (100%) | 32 ( 97%) | NS |
| Potassium<br>[mg/day] | 2559.2 ± 695.8<br>899.7 - 4873.0<br>2535.7 | 2399.3 ± 717.6<br>899.7 - 3854.5<br>2373.8 | 2610.1 ± 736.3<br>1270.4 - 4873.0<br>2515.6 | 2673.1 ± 617.4<br>1462.7 - 3715.0<br>2676.6 | NS |
| Potassium intake below norm n (%) | 99 (99%) | 34 (100%) | 32 (97%) | 33 (100%) | NS |
| Magnesium<br>[mg/day] | 238.5 ± 80.5<br>63.0 - 508.9<br>224.5 | 238.2 ± 96.1<br>63.0 - 508.9<br>216.7 | 232.0 ± 70.6<br>131.0 - 412.0<br>218.7 | 245.5 ± 73.7<br>123.7 - 399.3<br>233.5 | NS |
| Magnesium intake below norm n (%) | 89 (89%) | 28 (83%) | 32 (96%) | 29 (88%) | NS |
| Copper<br>[mg/day] | 0.9 ± 0.3<br>0.3 - 2.0<br>0.9 | 1.0 ± 0.4<br>0.3 - 2.0<br>0.9 | 0.9 ± 0.3<br>0.5 - 1.7<br>0.9 | 1.0 ± 0.3<br>0.5 - 1.8<br>0.9 | NS |
| Copper intake below norm (%) | 15 (15%) | 7 (21%) | 4 (12%) | 4 (12%) | NS |
| Iron<br>[mg/day] | 9.1 ± 2.9<br>3.6 - 16.4<br>8.6 | 8.8 ± 3.1<br>3.6 - 16.4<br>8.9 | 9.1 ± 2.6<br>5.2 - 16.2<br>8.5 | 9.5 ± 3.0<br>4.9 - 15.8<br>8.6 | NS |
| Iron intake below norm n (%) | 81 (81%) | 30 (88%) | 26 (79%) | 25 (76%) | NS |
| Zinc<br>[mg/day] | 8.2 ± 2.6<br>2.9 - 15.5<br>7.7 | 7.8 ± 2.7<br>2.9 - 13.4<br>7.5 | 8.3 ± 2.3<br>4.9 - 14.3<br>7.8 | 8.6 ± 2.7<br>5.1 - 15.5<br>7.6 | NS |
| Zinc intake below norm n (%) | 66 (66%) | 18 (53%) | 25 (76%) | 23 (69%) | NS |

[1]mean±standard deviation, [2]range, [3]median, * value for *ANOVA* test or *chi*$^2$ test, ** differences statistically significant (p≤0.05) marked with letters (a-b), NS- differences are not statistically significant (p>0.05)

An excess of body weight in cancer patients may be the result of decreased physical activity, a diet over-rich in calories, changes in metabolism and endocrine function together with the effects of treatment. A very commonly seen side-effect of treating breast cancer is increased body weight, for instance when combination therapy is adopted. A high BMI at the time of diagnosing breast cancer, as well as the increase in body mass during treatment are positively correlated with a worsening prognosis and mortality risk. Furthermore, there is an increasing amount of evidence demonstrating the link between recurrence of breast cancer with overweight [1, 5, 12]. Compared to women with a 0.5 BMI increase, those in whom the BMI rose by 0.5 - 2 BMI units had a 40% greater chance of recurrence, which increased to 53% in those showing rises above 2 BMI units [19]. A prospective USA study by *Calle* et al. [4] showed an increase in mortality risk due to cancer linked with body mass. The relationship between an excess dietary intake of calories and cancer has been extensively demonstrated in many animal models studied (eg. rats and mice), where increasing energy consumption is thought to stimulate the development of breast tumours. A study by *Phoenix* et al [24] suggests that high calorie diets can promote tumour development and the expression of the pro-inflammatory adipokinins leptin and resistin. However the link between a diet containing too many calories and the incidence of cancer is as yet not fully understood. It is suggested that leptin protein derived from fat tissue may exert a carcinogenic effect through stimulating angiogenesis and tumour cell proliferation. A diet with lowered calories may however decrease the body's leptin levels [6, 24]. Another carcinogenic factor is high levels of blood glucose for which it is considered, that tumours require high glucose concentrations for their proliferation [28]. A study by *Wayne* et al. [32] demonstrated a daily calorific consumption of 1506 kcal, a study by *Hebert* et al. 1727 kcal/day [13] and *Beasley* et al [3] showed a range between 1077 to 2407 kcal/day depending on the sub-group investigated. Lung cancer patients showed values of 1782 kcal/day according to *Bauer* et al. [2].

Reducing the amount of dietary fat is thought, not only to increase mortality, but also decrease the risk of cancers recurring. Animal studies have shown increases in tumour mass when the proportion of dietary fat is also increased that constitutes above 20% of the calorific value of a given diet [6]. A 'Women's Intervention Nutrition Study' indicated that those women limiting dietary fat below a level that supplies 20% of a diets calories, results in the risk of recurring tumours being reduced by 24%. It is suggested that this effect might be higher in women that lack oestrogen receptors [9]. Together with other authors, the presented study shows that women with breast cancer consume too many dietary calories derived from fat as demonstrated by *Wayne* et al. [32], *Beasley* et al [3], and *Heberta* et al [13] with respective levels of 34.5%, 23-39% and 34%. An observation also made on these breast cancer women showed a link between a diet rich in saturated and trans-saturated fat with a decrease in mortality, where a 13% calorific dietary level derived from saturated fats demonstrated a 41% increase in mortality risk over those with levels of 7%. Furthermore in this same study, women who consumed twice more energy derived from trans fats had a 78% higher risk of mortality than women consuming half less [3]. It is important that an appropriate ratio of dietary *omega*-6 to *omega*-3 fats be observed. Some current studies suggest that the *omega*-3 fats may beneficially effect persons suffering from cancer. They not only act as anti-inflammatories and immune function modulators but they apparently inhibit tumour growth and angiogenesis, ameliorate cachexia, improve the quality of life and enhance the effects of treatment [11, 32].

An adequate protein intake is vital during treatment as well as afterwards. The adaptive mechanism that enables protein metabolism to slowly rise together with the protection afforded against breakdown of non-fat body mass seen in fasting subjects, is absent in cancer patients, thus leading to protein reserves becoming depleted and in some cases to muscular atrophy. The current study showed that protein intake in those suffering from breast and lung cancer were slightly less than found in other studies [2, 9, 22]. It was also observed that the cancer patients consumed somewhat lowered levels of carbohydrate, which was similarly seen in a study by *Wayne* et al. [32]. The *Beasley* et al. study demonstrated that the proportion of dietary energy derived from carbohydrates in women with cancer was 49-63%. However the *Hebert* et al. study [13] revealed an even smaller consumption at 103 – 180 g/day. The main source of dietary carbohydrates should be vegetables, fruit and wholegrain products that are rich in nutrients, phytochemicals and fibre. It is found that these components can all reduce the risk of developing cancer and halt its progression [27]. Low fibre intakes have however been noted in this and other studies; 13.4 – 14.5 g/day *Hebert* et al. [13] in breast cancer patients, and 13.5 g/day in those with lung cancer, *Bauer* et al. [2]. Dietary fibre is known to support gastro-intestinal function, decreases blood cholesterol some authors claim that it can also reduce the risk of developing certain tumours.

This paper also indicates a deficiency of vitamin C consumption in the cancer patients. Study by *Nissen* et al. [23] and *Saquib* et al. [26] gave daily intakes of 107 mg and 105-132 mg. The vitamin A levels found agreed with a study by *Lange* and *Pyzalska* [22], however both were less than those recorded in other works [3, 23]. In all 3 study groups, vitamin E consumption were close to recommended values as well as to the results obtained by *Nissan* et al. [23] and *Saquib* et al. [26] where women with breast cancer daily consumed respectively 7.9 mg and 9-10 mg.

It is the authors suggestion that women suffering from breast cancer who consume larger amounts of β-carotene and vitamin C have decreased mortality risk compared to those with lower intakes of these vitamins. Many authors recognise that an adequate consumption of the antioxidant vitamins such as A, C or E may be beneficial to persons suffering from cancer. Each of these 3 vitamins protect DNA against oxidative damage and strengthen the immune system. Vitamins A and E stimulate suppressor genes, deregulate oncogenes and inhibit tumour angiogenesis. Retinol regulates cellular differentiation and stimulates apoptosis, thereby it can halt carcinogenesis. Experiments have demonstrated that α-tocopherol inhibits the nitrosation of amines both *in vivo* and *in vitro* in a fat soluble environment (just like vitamin C does under water soluble conditions), it inhibits the development of skin cancer induced by UV radiation and it inhibits tumour growth induced by polycyclic aromatic hydrocarbons. In addition, it is considered that vitamin E can potentiate selenium inhibition of carcinogenesis [7, 14, 26, 35].

The current study furthermore also shows, that intakes of calcium and magnesium in all 3 study groups were insufficient. Likewise, similar deficiencies were also observed by *Saquib* et al [26]. It is considered that high intakes of these minerals can afford protection against breast and large bowel cancer whilst conversely, low dietary intakes are linked with an increased risk of morality due to breast cancer. Intakes of copper in the presented study are in line with recommended values, however the *Saquib* et al. study [26] noted a twice higher intake of this trace element. Copper forms part of the superoxide dismutase complex which takes part in the first line of defence against cancer development by amongst other things, facilitating the reaction between free oxygen radicals and various 'mopping up' biological compounds. Dietary iron intakes were found to be inadequate especially for women with breast cancer, however *Saquib* et al. [26] showed that their subject women with breast cancer had adequate intakes. It is seen that high iron consumption, leading to high free iron in the body, may potentiate the effect of oestradiol, ethanol and ionising radiation - which are 3 independent factors that cause breast cancer. In contrast, deficiencies in iron intake can compromise immune function and increase the risk of upper digestive tract tumours occurring. The *Saquib* et al. study

[26] reported that 9.8 mg zinc was consumed daily by breast cancer patients. It is considered that zinc intakes in cancer patients is important as it also forms part of the antioxidant superoxide dismutase complex. Zinc deficiencies can lead to decreased immune function and low blood levels are linked to increase risks for developing tumours of the breast, lung, bladder, buccal cavity and ovaries [14, 16, 30].

## CONCLUSIONS

1. The intake of dietary calories was found to be inadequate in all 3 patient groups, ie. those with cancer of the breast, lung and bones or soft tissue. The proportions of energy derived from dietary fat and protein were somewhat raised, whereas for carbohydrates this was low. Subjects with breast cancer derived significantly more calories from dietary protein compared to those with cancers of the lung and bones or soft tissue.
2. The greatest difficulties that subjects showed were in keeping to dietary intake guidelines for protein, carbohydrates, fibre, Vitamin C, calcium, magnesium and iron.
3. Due to the increased mortality of patients suffering from malignant cancers, it is important that nutrition is monitored and that such further studies are conducted.

**Conflict of interest**

*The authors declare no conflict of interest.*

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