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ORIGINAL PAPER

DIETARY MAGNESIUM INTAKE IN THE POLISH POPULATION OF ONCOLOGICAL PATIENTS*

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Abstract

Oncological diseases are a major global public health concern. Magnesium deficiency is a complex condition and it is difficult to assess the magnesium status in a body as magnesium serum levels have little correlation with the total body magnesium status. The aetiology of certain forms of cancer is partly related with an intake of magnesium, especially in colorectal cancer patients and in males. Thus, the aim of the present study has been to provide more recent data about magnesium dietary intake among oncological patients. We analysed 24-hour dietary reliable surveys from 304 participants aged ≥ 19 years old from the Clinical Department of Oncological Surgery, MSW Hospital, Olsztyn, Poland, from three wards: chemotherapy, radiotherapy and surgery. Data were collected between January 2013 and April 2016. The mean magnesium dietary intake was 224 ± 13 mg per day among women and 295 ± 15 mg per day among men. When compared with the estimated average requirement of people over 30 years of age (265 mg per day for women, 350 mg per day for men), this was found insufficient. In addition, the magnesium intake decreased with increasing age ($p < 0.01$), and men had higher intakes of magnesium than women ($p < 0.01$). Slight variations were observed in certain groups distinguished according to education. Place of residence had the least effect on the magnesium status in analysed diets. Additionally, dietary supplementation with magnesium was scarce and insufficient among the oncological patients (1%). Many oncological patients fail to consume adequate magnesium in their diets. Patient education is needed to adopt an adequate and balanced diet which will provide support for oncological treatment to be more effective.

Keywords: cancer, hypomagnesemia, magnesium.

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INTRODUCTION

Next to phosphorus, potassium, sodium and calcium, magnesium is another valuable element for health. In the human body, magnesium is involved in DNA repair and synthesis, neuromuscular excitability, muscle contraction and relaxation (Gourgoulianis et al. 2001), as well as transport of calcium and potassium ions through the cell membrane (Bara et al. 1993, Blaszczyk, Duda-Chodak 2013). Magnesium is a cofactor of approximately 300 enzymes. On the kynurenine pathway of tryptophan metabolism, magnesium is able to regulate quinolinate phosphoribosyl transferase, thus preventing the accumulation of toxic quinolinic acid (Majewski et al. 2016). Moreover, magnesium is involved in the catabolic and anabolic processes (Maggio et al. 2011) as well as in the synthesis of fatty acids (Całyniuk et al. 2016). Magnesium is in control of cardiovascular system and blood pressure (Wu et al. 2006, Kaplinsky, Alon 2013) as well as diabetes (Shahbah et al. 2017).

In most cases, magnesium deficiency is asymptomatic, although it may lead to severe complications such as seizures and cardiac arrhythmia. Also restlessness, agitation, nervousness, irritability, attention-deficit hyperactivity disorder in children, depression, migraine, headache, muscle cramps, stroke, inflammation and oxidative stress have been reported with magnesium deficiency (Petrault et al. 2002, Rayssiguier et al. 2006, Yary et al. 2013, Chandrasekaran et al. 2014, Bain et al. 2015, Black et al. 2015). As magnesium is involved in many essential biological processes, it is extremely important to treat hypomagnesaemia according to its severity and proper magnesium serum concentration (Shahbah et al. 2017).

A high normal serum magnesium concentration can protect against a variety of diseases, and possibly contribute to treatment of cardiac arrhythmia, myocardial infarction and asthma (Gyamlani et al. 2000, Wilkes et al. 2002, Petrov et al. 2014). A higher dietary magnesium intake may have a protective effect towards colorectal cancer (Ko et al. 2014), and decrease the risk of morbidity in men due to colorectal cancer (Ma et al. 2010).

Despite such a crucial physiological role of magnesium, thus far surveys have shown that the dietary intake of magnesium is inadequate in the human population worldwide (Morgan, Stampley 1988, Galan et al.1997). Also oncological patients are at a great risk of magnesium deficiency due to chemotherapy, concurrent nausea and vomiting, and an inadequate intake of magnesium-rich food products (Majewski et al. 2017). The important role of magnesium makes its deficiency a potential health hazard. Unfortunately, little is known about the dietary magnesium intake in large, representative populations of oncological patients, especially in European countries.

MATERIAL AND METHODS

Subjects

The present study was based on a survey conducted among patients in the Oncology Polyclinic at the MSW Hospital in Olsztyn, Poland, staying in one of the three wards: Radiotherapy, Chemotherapy and Oncological Surgery after their admission to the hospital from January 2013 to April 2016. The study enrolled 380 patients, from which 304 (152 men and 152 women) reliable and complete surveys were selected for further evaluation. Patients enrolled in the study were diagnosed with lung (29.5%), colorectal (17.0%), prostate (12.5%), liver (6.8%), larynx (6.8%), head (5.7%) and stomach (5.7%) cancer in men. Whereas among women, the most common sites diagnosed were: cancer of lung (20.0%), breast (20.0%), colorectal (16.0%), ovary with cervix (8.0%), liver (6.7%), uterus (5.3%) and skin (5.3%).

First, participants were asked to complete an anonymous general questionnaire comprising socio-demographic and anthropometric elements, including age, body mass and height. Body mass index was calculated by using height and body weight. The second part included a 24-hour dietary recall by trained dieticians using an EPIC-SOFT computer program. During a recall, the patients needed to report the types and quantities of all foods and beverages consumed during a normal day at home. After 2-3 days, another 24-hour interview was carried out for comparison of subject variability in nutrient intake. The results were compared with the Estimated Average Requirement (EAR) for a group of people.

Statistical analyses

The differences between mean intakes of nutrients were assessed using Student's t-test. The Levene's test was applied to check homogeneity of variance. One-way ANOVA with the *post-hoc* Tukey's test was performed to compare groups. All data are expressed as mean ± standard error of mean (S.E.M). Statistical analyses were conducted using IBM SPSS Statistics 24 (IBM Corp), and $p < 0.05$ was considered as statistically significant.

RESULTS

The patients' age ranged from 19 to 84 years with a mean of 65 ± 9 years and a median of 65 years in men, and 54 ± 8 years and median 55 years in women (Table 1). Eighty-one patients (26.64%) were ≤ 50 years and 223 patients (73.36%) were > 50 years of age.

The mean magnesium intake was 295 ± 15 mg daily in men (EAR for magnesium in men is 330-350 mg daily) and 224 ± 13 mg daily in women

Table 1

Demographic characteristics of oncological patients

Parameter	Men (n = 152)		Women (n = 152)	
	mean*	median**	mean*	median**
Age (y)	65.00 ± 9 (19 - 84)	65	54.00 ± 8 (18 - 79)	55
Body weight (kg)	76.44 ± 13.78 (50 - 112)	75	65.61 ± 12.27 (43 - 98)	62.5
Height (cm)	173.8 ± 8.01 (157 - 205)	173	161.7 ± 6.56 (145 - 178)	161
BMI (kg m^{-2})	25.33 ± 4.27 (16.54 - 38.97)	25.21	25.10 ± 4.47 (17.42 - 38.14)	24.49

* Values are mean ± S.E.M, with min-max; ** values are medians; BMI – body mass index.

(EAR 255-265 mg daily), and the difference between the analysed groups was statistically significant ($p < 0.01$) – Table 2. In addition, daily magnesium intake decreased with increasing age ($p < 0.01$).

Table 2

Daily magnesium intake in oncological patients in certain age groups

Age group (y)	Men				Women				P (men *vs* women)*
	n = 152	magnesium intake (mg/day)			n = 152	magnesium intake (mg/day)			
		mean*	median**	EAR		mean*	median**	EAR	
19-30[a]	8	320 ± 20	299	330	11	238 ± 10	212	255	**<0.001**
31-50[b]	26	317 ± 14	280	350	36	226 ± 13	204	265	**<0.001**
51-70[c]	83	294 ± 11# c≠a≠b	262	350	89	222 ± 7# c≠a	203	265	**<0.01**
≥70[d]	35	270 ± 19# d≠c≠b≠a	231	350	16	195 ± 8# d≠c≠b≠a	181	265	**<0.01**

* Data expressed as means ± S.E.M; significant differences are displayed in bold (Student's t-test); ** values are medians; # indicate significant difference, $p < 0.01$ (one-way ANOVA with post-hoc Turkey's test)

The percentage of patients with dietary magnesium intakes according to EAR guidelines is presented in Table 3. Most of the oncological patients fell within the group having a daily intake below the EAR.

Table 3

Percentage of patients with dietary magnesium intakes compared with the estimated average requirement (EAR)

EAR	Men (%)	Women (%)
≥EAR	16.6	18.3
2/3 EAR – EAR	68.4	71.9
1/3 EAR – 2/3 EAR	12.7	7.9
< 1/3 EAR	2.3	1.9

Among oncological patients, intakes of magnesium were positively related with the educational level, both in men and women. People with higher education had a greater magnesium intake in comparison to patients with primary education, $p < 0.05$ (Table 4).

Table 4

Dietary magnesium intake *vs* educational level

Education	Men			Women			*P* (men *vs* women)*
	n = 152	magnesium intake (mg/day)		*n* = 152	magnesium intake (mg/day)		
		mean*	median**		mean*	median**	
Primary or none[a]	57	278 ± 15	245	40	207 ± 7	186	**<0.01**
Secondary[b]	76	292 ± 13	268	69	221 ± 12	195	**<0.01**
Higher[c]	19	325 ± 19# a≠c	296	43	232 ± 9# a≠c	205	**<0.01**

* Data expressed as means ± S.E.M; significant differences are displayed in bold (Student's *t*-test); ** values are medians; # indicate significant difference, $p < 0.05$ (one-way ANOVA with post-hoc Turkey's test)

No correlation was seen within the group of men or women as to the magnesium content in daily diet and the patients' place of living (Table 5).

Table 5

Dietary magnesium intake; urban *vs* rural environment

Place of living	Men			Women			*P* (men *vs* women)*
	n = 152	magnesium intake (mg/day)		*n* = 152	magnesium intake (mg/day)		
		mean*	median**		mean*	median**	
Village	39	277 ± 15	263	44	209 ± 9	183	**<0.01**
City up to 10,000	25	314 ± 18	291	21	231 ± 14	209	**<0.01**
City up 10,000-50,000	46	301 ± 13	278	44	235 ± 12	212	**<0.01**
City above 50,000	42	269 ± 20	253	43	217 ± 11	198	**<0.01**

* Data expressed as means ± S.E.M; significant differences are displayed in bold (Student's *t*-test); ** values are medians

Only 67 patients (22% of respondents) used supplementation with vitamins and minerals, although only 3 patients declared magnesium supplementation 3 patients – Table 6.

Table 6

Magnesium deficiency associated with nutritional habits

Foodstuff	Magnesium deficit	References
Coffee and strong tea	increased excretion	Blaszczyk, Duda-Chodak (2013)
Excessive fat intake	reduced absorption	
Fast or prolonged loss of weight	low protein and high fibre diet	
Excessive alcohol consumption	increased excretion reduced absorption	Linnoila et al. (1979)
Foodstuff containing phosphates	magnesium binding	Zea et al. (2008)
High calcium intake	reduced absorption	Bonny et al. (2008)

DISCUSSION

The survey revealed that diets of a large proportion of oncological patients did not contain adequate amounts of magnesium. In our study, the median dietary intake of magnesium was lower than the Estimated Average Requirement in all groups, which suggests that the magnesium intake from dietary sources in oncological patients remains insufficient. This was also observed in previous studies worldwide in oncological patients (Saquib et al. 2011, Surwillo, Wawrzyniak 2013, Majewski et al. 2017). Slight variations were observed according to socio-professional and educational levels. Younger people and those with higher education had statistically a significant higher magnesium daily intake when compared to other groups. People with less education and the elderly, had particularly lower intakes of magnesium. Urban versus rural residency had the least effect on the magnesium status in analysed diets. However, far more highly educated younger people (consuming better designed, magnesium-rich diets) were living in cities with a population of above 50,000 in comparison to other places, so it seems to be correlated with magnesium in daily diet. However, in our study it was not an issue.

In such cases, supplementation can be an important alternative source of magnesium. However, in our study, a large proportion of the participants did not consume supplements, and in the group of patients who did consume magnesium supplements (3 patients – 1%), the dietary intake of magnesium was also below recommendations.

Our analysis did not include magnesium from water intake. Tap water is not thought to be a major source of magnesium intake for most people (Gourgoulianis et al. 2001), although water with a high mineral content (mineral water), or "hard" water, might be a source of magnesium. Low magnesium may also be a result of excessive coffee, strong tea or alcohol intake, together with malnutrition (Table 6).

Despite the physiological role of magnesium and its proven and potential benefits, surveys show that the dietary intake of magnesium is inadequate in oncological patients (Table 2), as well as in other populations worldwide (Morgan, Stampley 1988, Galan et al. 1997, Ford, Mokdad 2003). These findings may raise an issue of the adequacy of the magnesium status in hospitalised patients (Altura et al. 2002).

CONCLUSIONS

1. Many oncological patients fail to consume adequate magnesium in daily diet. Our study confirms that oncological patients are at risk of dietary magnesium insufficiency. There is a severe threat of hypomagnaesemia in the population of oncological patients.

2. A healthy balanced diet could help to correct the overall nutritional status and reverse some dysfunctions, and thus improve the health status of oncological patients and favour their return to normal functioning.

DECLARATION OF INTEREST

The authors declare that they have no conflict of interest.

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