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Magnesium and trace element intake after a lifestyle intervention.

Running title: Mg, trace elements and lifestyle intervention

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Abstract

Objective: Observational studies suggest that some trace elements and magnesium (Mg) improve glucose metabolism, markers of inflammation and oxidative stress, but supplementation studies have yielded inconsistent results. Our objective was to evaluate if a lifestyle intervention trial, aimed at reducing total and saturated fat and increasing fiber intake, can affect also the intake of selenium (Se), zinc (Zn), copper (Cu), chromium (Cr) and Mg. *Research Methods & Procedures:* Dietary intake of Se, Cr, Zn, Cu and Mg was evaluated at baseline and at the end of a lifestyle intervention trial performed in 335 dysmetabolic adults. *Results:* At baseline, trace element and Mg intake in the intervention (*n*=169) and control (*n*=166) groups of the trial were not significantly different. The former significantly increased their intake of Se, Mg, and Cr, while the latter reduced the intake of Mg, Zn and Cr. Between-group differences were significant for Mg, Cr and Se. *Conclusion:* Healthier lifestyle recommendations might improve the pattern of micronutrient and Mg intake, which might play an independent role in ameliorating some metabolic, inflammatory and oxidative markers.

Key words: trace elements, magnesium, lifestyle intervention, metabolic syndrome, glucose

Introduction

Dietary magnesium (Mg) and trace elements may play a role in the pathogenesis of metabolic disorders. The antioxidant selenium (Se) may exert beneficial effects on glucose metabolism, by insulin-like actions, even if recent studies suggest that Se status and supplementation may increase diabetes risk [1-2]. Zinc (Zn) stabilizes the structure of insulin granules and displays insulinomimetic effects; its deficiency might be implicated in the development of insulin resistance and increased susceptibility to oxidative damage [3]. Data about copper (Cu) are conflicting: inverse and direct relationships between serum/dietary Cu and glucose and total cholesterol concentrations were reported [4-5]. Finally, chromium (Cr) might act as an insulin-mimetic factor and antioxidant. The supplementation with Cr-picolinate significantly improved insulin sensitivity, glucose control, and reduced body weight gain in type 2 diabetic patients [6-7].

Increased Mg intake reduced the incidence of diabetes, metabolic syndrome, hypertension, and cardiovascular disease, by ameliorating insulin resistance, serum lipid profiles, and lowering inflammation, endothelial dysfunction, and oxidative stress [8].

We have recently demonstrated with a randomised controlled trial that a lifestyle intervention based on general recommendations significantly reduced total/saturated fat intake and increased polyunsaturated fat and fiber intake in the intervention group of the trial and that these dietary variations favourably affect the prevalence of multiple metabolic/inflammatory abnormalities [9-10].

The aim of the present paper was to evaluate if this lifestyle intervention aimed at reducing total and saturated fat and increasing fiber intake can affect also the intake of Mg, Se, Zn, Cu and Cr.

Materials and Methods

The trial was performed in 335 dysmetabolic patients from a population-based cohort [9]. From December 2004 to December 2005, the patients were randomized to receive either the lifestyle intervention program according to recommendations carried out by trained professionals (intervention group, *n*=169), or standard counseling given by the family physician (control group,

n=166) [9]. This 1-year randomised, prospective open trial was approved by the local Ethical Committee, all patients gave their written informed consent, and procedures conformed to the Helsinki Declaration principles.

The patients were randomised to receive either a lifestyle intervention program according to recommendations carried out by trained professionals (intervention group, *n*=169), or standard counselling given by the family physician (control group, *n*=166) [9]. This 1-year randomised, prospective open trial was approved by the local Ethical Committee, all patients gave their written informed consent, and procedures conformed to the Helsinki Declaration principles.

The intervention group received detailed verbal and written individualised dietary and exercise recommendations from trained professionals during dedicated sessions [9]. An individually prescribed diet was given (50-60% carbohydrates, 15-20% proteins, <30% fat, <10% saturated fat, up to 10% polyunsaturated fat, 20-30 g fiber). Before and after the study, all patients completed a validated semi-quantitative food-frequency questionnaire [9].

Each nutrient was adjusted for total energy, using the residual method [9].

No patient is using or had used in the past year micronutrient or Mg supplements.

The *t*-test for paired-data was applied to investigate within-group variable variations (after-before); the *t*-test for independent samples was performed to assess between-group differences in these variations.

Results

No significant difference was evident at baseline between groups, both for clinical and laboratory characteristics and intake of macronutrients [9]. The intake of Mg, Se, Zn, Cu and Cr did not differ between groups at baseline (Table 1). Intake of Mg, Se, and Cr increased in cases (Table 1), while Mg, Zn, and Cr decreased in the controls. The between-group differences resulted significant for Mg, Se and Cr intake.

Discussion

Healthier lifestyle recommendations increased the dietary intakes of Mg and some trace elements, which might play an independent and additive role in improving some metabolic or inflammatory abnormalities, as reported in literature. Increased Mg intake was reported to ameliorate insulin resistance, serum lipid profiles, and to lower inflammation, endothelial dysfunction, and oxidative stress, ultimately reducing the risk for cardiovascular disease [8].

Cr significantly increased in our intervention group; Cr supplementation significantly improved insulin sensitivity and glucose concentrations in type 2 diabetic patients [6-7]. A systematic review of randomised controlled trials showed that Cr supplementation improved fasting glucose by –1.0 mmol/l [7].

The intervention group increased the intake of Se, which is required for activity of key antioxidant enzymes, playing a protective role against oxidative stress [2].

Zn deficiency might led to insulin resistance [3], however, intervention studies found no beneficial effects for Zn supplementation on plasma glucose and lipid values [1], but an adverse effect on HDL-cholesterol; it did not protect against protein oxidation, but may promote toxic reactive oxygen species [11]. In our patients, no significant between-group difference in zinc dietary intake was found.

Variation in dietary Cu intake after the trial in both our groups was minimal. Inverse relationships between serum/dietary Cu and total cholesterol concentrations were reported [4]. Indeed, the reported pro-oxidant effect of Cu and its increased concentrations during various chronic inflammatory diseases well described the controversy around this element, due both to the adverse metabolic pattern linked to its deficiency and the unfavourable associations of increased Cu intake [5].

Exposure to some trace element supplementation might be harmful, since higher incidence of diabetes, cardiovascular risk factors, thrombogenesis , mortality have been described. The relatively narrow therapeutic range of many elements might be due to the generation of reactive oxygen

species [11]. Furthermore, in the absence of underlying specific deficiency, no dietary mineral supplement has proven definitively useful so far for the prevention of metabolic diseases in the general population [1]. The discrepancy might be due to the fact that their increased dietary intakes are indirect surrogate markers of fruit and vegetable intakes, that are related to a healthier lifestyle. Therefore, the protection might derive from multiple nutrients and their combination, rather than from a single substance. Accordingly, in our lifestyle intervention study, a healthier style was associated with a better overall micronutrient pattern.

Limitations

Dietary assessments were carried out using a semi-quantitative food-frequency questionnaire, and validity and reliability of trace element intake assessment are unknown (e.g. the level of Se in different food may widely vary depending on the soil content; dietary Cr content is quite variable in food sources, etc). Measurement errors, however, could have rather reduced the differences in the intakes. Furthermore, randomisation procedures should have minimised the likelihood of confounding by uncontrolled or unknown factors.

Conclusion

A healthier lifestyle is an efficacious modality to improve the intake of Mg and many trace elements contemporarily, without the need for exogenous micronutrient supplementation.

Conflict of interest

There is no conflict of interest.

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Table 1. Variations in magnesium and trace element dietary intake before-and-after the lifestyle intervention, by group[1]

	Intervention Group (*n*=169)				**Control Group (*n*=166)**				
Variables	***Before***	***After***	***Difference***	***P*[2]**	***Before***	***After***	***Difference***	***P*[2]**	**P[3]**
Mg (mg/day)	302.9±81.2	340.4±73.2	37.5	<.001	310.8±90.9	289.3±90.3	-21.5	<.001	<.001
Se (µg/day)	54.6±10.7	60.5±9.6	5.95	<.001	54.1±13.1	55.5±9.2	1.44	.13	<.001
Zn (mg/day)	12.4±4.8	12.1±4.3	-0.26	.06	12.4±4.5	12.1±4.5	-0.28	.04	.92
Cu (mg/day)	1.7±0.7	1.7±0.1	0.01	.85	1.7±0.8	1.7±0.1	0.02	.80	.94
Cr (µg/day)	65.1±20.9	68.5±22.6	3.41	<.001	64.2±17.0	61.3±20.1	-2.89	.02	<.001

[1]Values are means ± SD.

[2] p values obtained by comparing differences in the variable values within each group, using *t*-test for paired-data

[3]p values obtained by comparing differences in the variable values between the two groups, using Student's t-test.