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Do Dietary Fibers Impact the Bioavailability of Magnesium among Type 2 Diabetic Patients?

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Abstract

Background: The intake of dietary fiber has been shown to impair the absorption of minerals and trace elements in the small intestine because of their binding and/or sequestering effects.

Objective: This study aimed to investigate the effect of water soluble fiber supplementation from psyllium on magnesium level among type 2 diabetes patients.

Method: Forty Type 2 diabetes patients, non-smokers, aged >35 years were stratified and simply randomized into two groups; the intervention group, which consists of 20, who were given 10.5 grams of dietary fibers daily, and the control group. Which consist of 20 participants who continued on their regular diet for eight week duration.

Results: After 8 weeks of soluble fiber supplementation, the study showed remarkable and significant reduction in the (FBS) before and after the intervention in the intervention group (163.11 to 116.56 mg/dL), while in the control group, a minor reduction in the fasting blood sugar was reported (156.39 to 151.22 mg/dL). The results did not report any significant changes in the magnesium levels at the end of the intervention program between the two groups (p = 0.580), when Repeated Measure ANOVA was used.

Conclusion: The inclusion of moderate amounts of psyllium to the normal daily diet is safe and dose not decrease magnesium level in the plasma among type 2 diabetes patients.

Keywords: Diabetes; Fiber; Psyllium; Magnesium; Gaza

Introduction

Magnesium (Mg) is one of most abundant mineral in the human body. A lot of metabolic functions can be affected by cellular magnesium level [1] as it acts as a cofactor for more than 300 biochemical reactions. Magnesium is required for DNA and RNA synthesis, reproduction, and protein synthesis. Moreover, magnesium is essential for the regulation of muscular contraction, blood pressure, insulin metabolism [2]. The bioavailability of magnesium plays a vital role in the reactions that generate and use ATP (Adenosine Tri-Phosphate), the fundamental unit of energy within the body's cells [3,4]. Type 2 Diabetes Mellitus (T2DM) patients generally suffer from both extracellular and intracellular hypo-magnesemia [5-7], knowing that body typically absorbs only 20-50% of ingested magnesium [8,9]. So understanding the factors that can improve or prevent magnesium absorption and bioavailability is an important first step to addressing deficiencies in magnesium level, especially among diabetic patients where chronic latent Mg deficit is common [5].

It is well documented that dietary fibers are a significant component of human diet and play a vital role in human health [10]. However, two types of fiber exist, water insoluble and soluble fibers, and both are considered healthy [11]. Water soluble fibers (SF) found to improve and prevent diabetes [12,13], dyslipidemia [14], cardiovascular disease and other conditions [15]. Because dietary fibers and some associated substances, such as phytate, have in vitro mineral-binding capacities, they have been thought to exert negative effects on absorption of some minerals such as calcium, iron and zinc, although magnesium absorption seems to be less affected [16]. Indeed, the effect of dietary fibers on minerals depends largely on their own nature and characteristics [17]. The aim of this study is to determine whether soluble fiber supplementation from psyllium decreases magnesium level in the plasma in T2DM patents after eight weeks of intervention.

Subjects and Methods

Subjects

Forty newly discovered Type 2 diabetic patients, non-smokers, aged >35 years of both sexes, were stratified into different strata according to sex, age, body mass index (BMI) and fasting blood sugar (FBS) and randomly allocated into either intervention or control group.

Study design

This study utilized a clinical randomized controlled trial that conducted on 40 newly discovered Type 2 diabetes patients who were

on oral anti-diabetes medication. Subjects were randomly stratified and allocated into two groups. The control group (Group A) consists of 20 participants, who did not receive any food supplements throughout the intervention period and continued with their regular diet. While, the intervention group (Group B) consist of 20 participants who were on soluble fibers supplementation for eight weeks along with their regular diet.

The intervention groups receive supplementation of soluble fiber 10.5 g daily. The intervention protocol was designed in a way that 7.0 g of soluble fiber was given to the intervention group subjects 15 minute before lunch and 3.5 g of soluble fiber 15 minutes before dinner. Respondents were instructed to consume soluble fiber (psyllium) with an adequate amount of water to prevent choking (first stir the fiber dose well in 100 ml of water and drink it, then drink additional 50 ml of water).

To insure subjects' compliance to the intervention program, subjects were contacted by phone 3 times weekly and they were instructed to fill up the compliance checklists to record the daily consumption of the soluble fiber doses, these checklists were collected weekly. The magnesium level pre and post intervention was measured for both groups.

Data Analysis

Following data collection, all data were reviewed before being entered into the study database. Data were entered into an SPSS (Statistical Package for Social Sciences) version 18.0 for Windows. The data analysis was divided into two steps: descriptive statistics and analysis of variance. The data are presented in tables. The quantitative data are represented in the form of proportions (%) and of means with standard deviations or medians. Magnesium level of the two groups was compared at the baseline, and after eight weeks of intervention. To evaluate the impact of soluble fibers on magnesium utilization, repeated measure ANOVA was used. The level of significance was set at 0.05.

Results

The results of this study consist of two important sections. The first one is the baseline characteristics of the respondents, while the second one is the changes in the magnesium level. The aim of this study is to determine whether soluble fiber supplementation decreases magnesium level in the plasma in T2DM patents.

Table 1 presents the socio-demographic and socio-economic characteristics of the respondents. The mean age of the responders was 47.3 years ranging from 41 to 57 years. The majority of the responders (44.4%) had attained a university level of education, 11.1% had diploma certificates, 22.2% obtained secondary school level, and 22.2% had attained a low educational level (Primary to preparatory education). The average household size was 7.08, and the number of families ranged from 2 to 11. This average household size (5.7) was higher than the average household size of in Gaza and West Bank, which is 5.11(Palestinian Central Bureau of Statistics 2014).

Almost, 97.22% of the total respondents were married and 2.77% were widowed. Majority (80.6%) of the respondents were breadwinners and working as governmental or self-employees, and 19.4% did not have any type of job. The average of total income was 2211.11 NIS, and 36.1% of all respondents depend on regular humanitarian aids. The relative poverty and the deep poverty lines according to consumption patterns (for reference household consisted of 2 adults and 3 children) in the Palestinian Territory in 2010 were 2,237 NIS, and 1,783 NIS respectively, meaning that 52.8% of the respondents are living under relative poverty, out of them, 47.2% were living in absolute or deep poverty households.

Profile	Variables	Mean SD	Frequency	Percentage
Age in years		47.3 (3.86)		
Gender	Male		18	50.00%
	Female		18	50.00%
	Total		36	100.00%
Place of residency	North Gaza		4	0.00%
	Gaza		6	0.00%
	Middle		6	0.00%
	Khan Younis		11	80.55%
	Rafah		9	19.44%
	Total		36	100.00%
Specific place	City		19	53.80%
	Refugee camps		4	11.10%
	Villages		13	35.10%
	Total		36	100.00%
Type of housing	Owner		36	100%
	Tenant		0	0.00%
	Total		36	100.00%
Educational level	Never been to school		0	0.00%
	Primary to Preparatory		8	22.20%
	Secondary school		8	22.20%
	diploma certificates		4	11.1% certificates
	University graduated		16	44.50%
	Total		36	100.00%
Family income (NIS)	Less than 1783 NIS[a]		17	47.20%
	Between 1783- 2236.9 NIS[b]		2	5.60%
	More than 2237 NIS[c]		17	47.20%
	Total		36	100.00%
[a]Deep or absolute poverty				
[b]Under relative poverty				
[c]Not poor				

Table 1: Socio-demographic and Socio-economic characteristics of respondents.

Table 2 shows no significant changes in the intervention group when compared with the control group after 8 weeks of soluble fiber supplementation. There was a trivial increment in the magnesium level in the intervention group (from 1.591 to 1.605 mg/dl) (Mean diff 0.02 mg/dl) after 8 weeks of intervention.

Variables	Control (n=18)		Intervention (n=18)		P value[a]
	Pre	Post	Pre	Post	
Mg level	1.68(0.135)[b]	1.68(0.110)	1.591(0.116)	1.605(0.125)	0.58
[a]Repeated Measure ANOVA between Control and intervention groups					
[b]Mean (Standard Deviation)					
The level of significance is <0.05					

Table 2: Differences in magnesium level in the control and intervention groups.

Figure1 illustrates the improvement in the fasting blood sugar after 8 weeks of dietary fiber supplementation. The results showed remarkable and significant reduction in the (FBS) before and after the intervention in the intervention group (163.11 to 116.56 mg/dL), while in the control group, a minor reduction in the fasting blood sugar was reported (156.39 to 151.22 mg/dL).

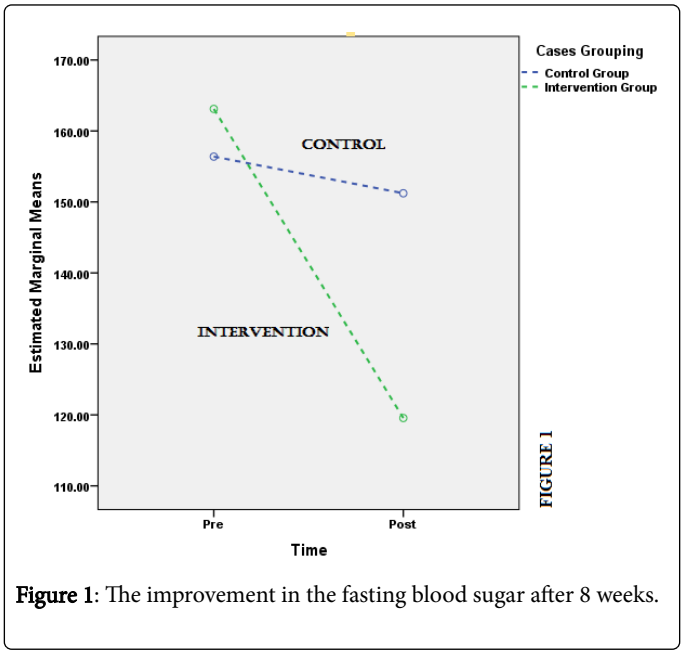

Figure 1: The improvement in the fasting blood sugar after 8 weeks.

Discussion

Magnesium is considered the second abundant intracellular micronutrient in the human body [4]. Magnesium ions regulate over 300 biochemical reactions in the body through their recognized role as enzyme co-factors [1]. The essentiality is a reflection of the role that magnesium plays in the stabilization of ATP and other molecules (4). Since then, researchers have come to realize that frank magnesium deficiency is rare and that it only occurs in clinical settings such as diabetes [7]. Intracellular hypomagnesaemia may result in disorders of tyrosine-kinase activity on the insulin receptor, an event related to the development of insulin resistance and decreased cellular glucose utilization [18], and is a common feature of patients with Type 2 diabetes [5].

The proposed mechanism by which Mg improve insulin sensitivity is that, magnesium works as a natural calcium antagonist [19], where magnesium and calcium compete with one another for the same binding sites on plasma protein molecules [20,21]. Because increases in intracellular free calcium may play a pathogenic role in the insulin resistance syndrome [22] and consider cell death trigger [23]. Interestingly, magnesium inhibits calcium-induced cell death [24].

Diets containing a good amount of dietary fiber can provide a lot of health benefits, such as helping to improve weight and glycemic index among T2DM [12]. However, fiber and some of the associated substances like phytate have strong in vitro mineral-binding capacities; hence fiber has been suspected of impairing Mg absorption [16]. More important, free phosphate may form insoluble salt complexes with magnesium; phosphate groups in phytate may also inhibit magnesium absorption [16]. Fiber rich foods have been shown to lower magnesium bioavailability [17]. However, it is not clear whether this was an independent effect of fiber or a reflection of the phytate content of these foods.

Results of this study pointed that, there is no statistical significant effect on magnesium level in the intervention group as compared with the control group after 8 weeks of soluble fiber from psyllium supplementation. There are different physicochemical properties and different biological effects of dietary fibers on the body [25]. Interestingly, the fermentable or soluble fibers, may enhance magnesium absorption to small degree in the healthy large intestine [17]. A lot of studies pointed that fermentable dietary fibers improve Mg status and absorption in the large intestine [26-28]. The exact way by which soluble fibers improve Mg bioavailability in human still unclearly understood. The proposed mechanisms in animal studies could be due to the fermentation of soluble fiber. The fermentation of soluble fiber increases an acidification of luminal contents, which tend to improve solubility of Mg, which easier and enhance the availability of Mg for transport across the ileal epithelium [29]. Also, fermentation of soluble fiber increase the production of SCFAs, the SCFAs stimulate Mg^{2+} transport via stimulation of a Mg^{2+}-$2H^{+}$ exchange mechanism [30,31].

Conclusion

The inclusion of moderate amounts of psyllium to the normal daily diet, dose not decreases magnesium level in the plasma in type 2 diabetes patients.

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Ethical consideration

This study delivered in accordance with Al-Azhar University-Gaza policies and procedures. We get approval from Deanship of the Faculty of Pharmacy, Graduate Studies, and Helsinki Committee. Also, there is no potential material interest that may or may appear to impair the independence and objectivity. Subject to the research being approved.

We are aware of our responsibility to be up to date and comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data. Finally, there is no risks on participants health's who were involved in this study.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Ihab A. Naser and Ayman S. Abutair conceptualized, supervised the study, both of them contributed to the data collection, data entry, data analysis and wrote the manuscript. All authors participated in the review of the manuscripts, read and approved the final manuscript.

References

1. Prasad AS (2013) Essential and Toxic Element: Trace Elements in Human Health and Disease: Elsevier.
2. Rude RK, Coates P, Betz J, Blackman M, Cragg G, et al. (2010) Encyclopedia of Dietary Supplements. Informa health care.
3. Ko YH, Hong S, Pedersen PL (1999) Chemical mechanism of ATP synthase magnesium plays a pivotal role in formation of the transition state where atp is synthesized from adp and inorganic phosphate. Journal of Biological Chemistry 274: 28853-28856.
4. Maguire ME, Cowan JA (2002) Magnesium chemistry and biochemistry. Biometals 15: 203-210.
5. Barbagallo M, Dominguez LJ (2015) Magnesium and type 2 diabetes. World journal of diabetes 6: 1152.
6. Chaudhary DP, Sharma R, Bansal DD (2009) Implications of magnesium deficiency in type 2 diabetes: a review. Biological trace element research 134: 119-129.
7. Tosiello L (1996) Hypomagnesemia and diabetes mellitus: a review of clinical implications. Archives of internal medicine 156: 1143-1148.
8. McCarthy JT, Kumar R (1999) Divalent cation metabolism: magnesium. Schrier R, series editor Atlas of Diseases of the Kidney 1: 4.1-4.12.
9. Bernstein L (2002) Improving Magnesium Absorption and Bioavailability. Geriatric Times 3.
10. Gao Y, Yue J (2012) Dietary fiber and human health. Cereals and Pulses: Nutraceutical Properties and Health Benefits 261-271.
11. Slavin J (1987) Dietary fiber: classification, chemical analyses, and food sources. Journal of the American Dietetic Association 87: 1164-1171.
12. Abutair AS, Naser IA, Hamed AT (2016) Soluble fibers from psyllium improve glycemic response and body weight among diabetes type 2 patients (randomized control trial). Nutrition Journal 15.
13. Sierra M, Garca JJ, Fernndez N, Diez MJ, Calle nP, et al. (2002) Therapeutic effects of psyllium in type 2 diabetic patients. European Journal of Clinical Nutrition 56: 830-842.
14. Grundy SM (2013) An International Atherosclerosis Society Position Paper: global recommendations for the management of dyslipidemia. Journal of clinical lipidology 7: 561-565.
15. Snchez-Muniz FJ (2012) Dietary fibre and cardiovascular health. Nutr Hosp 27: 31-45.
16. Bohn T, Davidsson L, Walczyk T, Hurrell RF (2004) Phytic acid added to white-wheat bread inhibits fractional apparent magnesium absorption in humans. The American journal of clinical nutrition 79: 418-423.
17. Coudray C, Demign C, Rayssiguier Y (2003) Effects of dietary fibers on magnesium absorption in animals and humans. The Journal of nutrition 133: 1-4.
18. Paolisso G, Barbagallo M (1997) Hypertension, diabetes mellitus, and insulin resistance: the role of intracellular magnesium. American journal of hypertension 10: 346-355.
19. Wacker WE (1980) Magnesium and man: Harvard University Press, United States.
20. Walser M (1967) Magnesium metabolism. Ergebnisse der physiologie biologischen chemie und experimentellen pharmakologie 59: 185-296.
21. Hunter DR, Haworth R, Southard J (1976) Relationship between configuration, function, and permeability in calcium-treated mitochondria. Journal of Biological Chemistry 251: 5069-5077.
22. Draznin B, Sussman K, Eckel R, Kao M, Yost T, et al. (1988) Possible role of cytosolic free calcium concentrations in mediating insulin resistance of obesity and hyperinsulinemia. Journal of Clinical Investigation 82: 1848-1852.
23. Orrenius S, Zhivotovsky B, Nicotera P (2003) Regulation of cell death: the calciumâ€“apoptosis link. Nature reviews Molecular cell biology 4: 552-565.
24. Reynolds JL, Joannides AJ, Skepper JN, McNair R, Schurgers LJ, et al. (2004) Human vascular smooth muscle cells undergo vesicle-mediated calcification in response to changes in extracellular calcium and phosphate concentrations: a potential mechanism for accelerated vascular calcification in ESRD. Journal of the American Society of Nephrology 15: 2857-2867.
25. Guillon F, Champ M (2000) Structural and physical properties of dietary fibres, and consequences of processing on human physiology. Food Research International 33: 233-245.
26. Coudray C, Bellanger J, Castiglia-Delavaud C, Remesy C, Vermorel M, et al. (1997) Effect of soluble or partly soluble dietary fibres supplementation on absorption and balance of calcium, magnesium, iron and zinc in healthy young men. European Journal of Clinical Nutrition 51: 375-380.
27. van den Heuvel E (1998) Application of dual stable isotope techniques to measure absorption of calcium, magnesium and iron in man: Maastricht university.
28. Coudray C, Bellanger J, Vermorel M, Sinaud S, Wils D, et al. (2003) Two polyol, low digestible carbohydrates improve the apparent absorption of magnesium but not of calcium in healthy young men. The Journal of nutrition 133: 90-93.
29. Heijnen AM, Brink EJ, Lemmens AG, Beynen AC (1993) Ileal pH and apparent absorption of magnesium in rats fed on diets containing either lactose or lactulose. British Journal of Nutrition 70: 747-756.
30. Leonhard-Marek S, GBEL G, Martens H (1998) Effects of short chain fatty acids and carbon dioxide on magnesium transport across sheep rumen epithelium. Experimental physiology 83: 155-164.
31. Chan J, Wypyszyk V (1988) A forgotten natural dietary fiber: psyllium mucilloid. Cereal foods world (USA).