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G.A. SPILLER[1] - T.S. PATTISON - C.D. JENSEN - L.G. WONG - J.H. WHITTAM and J. SCALA.

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Multivitamin-Mineral Supplementation: Effects on Blood Chemistries of College-Age Women.

G.A. SPILLER[1] - T.S. PATTISON - C.D. JENSEN - L.G. WONG - J.H. WHITTAM and J. SCALA.

Key words: Vitamins - Minerals - Supplementation - Women.

SUMMARY

Forty-two female college students, age 18-29 yr. and consuming nutritionally balanced meals in the college cafeteria participated. Subjects discontinued all vitamin-mineral supplements (VMS) for 17 days and were randomly assigned to one of two treatments, either a placebo, or VMS supplying the United States Recommended Daily Allowance (USRDA) of all vitamins, zinc, iron, iodine, copper, and 60% of the USRDA of calcium, 50% of magnesium and 45% of phosphorus. Treatments were consumed for 77 days. Fasting pre-and post-treatment blood chemistries were compared. VMS yielded significant increases ($p<0.05$) in serum vitamin B-12 (+25.05 pg/ml), vitamin C (+0.35 mg/dl) and folate (+7.40 ng/ml). No significant changes ($p>0.05$) in hematological or other blood chemistries were observed. Significant decreases in the number of below-normal serum indicators of vitamin status ($p<0.05$) and iron status ($p<0.005$) were seen with VMS. No significant changes were seen with placebo ($p>0.05$).

RIASSUNTO

Supplementazione multivitaminica e multiminerale: effetto sulla chimica del sangue in donne giovani.

Sono state studiate 42 studentesse (età 18-29 anni) che consumavano abitualmente pasti bilanciati della mensa scolastica. I soggetti smettevano la supplementazione vitaminica-minerale (VMS) per 17 giorni e venivano assegnati casualmente al gruppo placebo o a quello trattato con supplemento pari alle tabelle USRDA di tutte le vitamine, zinco, ferro, iodio, rame, 60% dell'RDA di calcio, 50% di magnesio e 45% di fosforo. Il trattamento continuava per 77 giorni. I parametri ematici a digiugno venivano controllati all'inizio ed alla fine di detto periodo. Il trattamento con VMS provocava un aumento significativo dei livelli di vitamina B_{12} (+25,05 pg/ml), di vitamina C (+0,35 mg/dl) e folato (+7,40 ng/ml). Non si è osservato alcun cambiamento significativo di altri parametri. Il trattamento con VMS determinava una diminuzione del numero di indicatori serici dello stato vitaminico e del ferro al di sotto della norma. Il trattamento con placebo non provocava alcuna variazione significativa.

INTRODUCTION

Surveys indicate that approximately 37% of adults in the United States take nutritional supplements regularly.[1] Vitamin-mineral supplementation persists despite the fact that except for iron[2] and perhaps calcium[3-7] in women, nutritional surveys suggest that vitamin-mineral inadequacies accompanied by overt deficiency symptoms are uncommon in the general American population.[2] Popular rationales for taking supplements include a desire for «nutrition insurance» and «increased vitality».[8]

Chronic malnutrition is known to impair physical working capacity,[9] immune function,[10] as well as cognition and behavior.[9] However, whether in a healthy, well-nourished population there exist chronic mild (subclinical) vitamin or mineral deficiencies which produce negative functional effects remains unanswered. Similarly, the ef-

1) Shaklee Research Center, HAYWARD, CA 94545 (U.S.A.).

fects of vitamin-mineral supplementation on biochemical indices and functional parameters of a healthy population, and its implication on possible subclinical nutrient deficiencies remains a public health issue in need of further research.

This study examined the effects of a daily multivitamin-mineral supplement on the blood chemistry values of college-age women.

MATERIALS AND METHODS

Subjects

Forty-two female adults between the ages of 18 and 29 yr. participated. All subjects were students at Mills College, Oakland, CA. The design and procedures followed in the study were approved by the Mills College Human Studies Review Board. Informed consent was obtained privately.

Design

The study was a double blind parallel comparison of two treatments. The experimental period consisted of an initial supplement-free phase lasting 17 days, and a treatment phase lasting 77 days. Subjects were instructed to consume their typical diets in the college cafeteria and to refrain from taking vitamin and/or mineral supplements or foods fortified with over 25 percent of the USRDA for any vitamin or mineral during the course of the study. After the 17 day supplement-free period, subjects were randomly assigned to one of two treatment groups by the method of random permuted blocks within strata.[11] The treatment groups contained equal numbers of smokers and oral contraceptive users. Fasting venous blood specimens were taken just prior to the consumption of treatments, and at the end of the study.

Treatments

Treatments (Table 1) consisted of either a 2 tablet dose vitamin-mineral supplement (Vita-Lea, Shaklee Corpora-

Table 1 - Vitamin-Mineral Supplement Nutrient Composition of 2 tablets (daily dose).

Nutrient	Unit of measure	% USRDA*
Vitamin A	5000 IU	100
Vitamin D	400 IU	100
Vitamin E	30 IU	100
Vitamin C	90 MG	150
Folic Acid	.4 MG	100
Thiamine	2.1 MG	140
Riboflavin	2.4 MG	140
Niacin	20 MG	100
Vitamin B-6	2 MG	100
Vitamin B-12	9 MCG	150
Biotin	.3 MG	100
Pantothenic Acid	10 MG	100
Calcium	.6 GM	60
Phosphorus	.45 GM	45
Iodine	150 MCG	100
Iron	18 MG	100
Magnesium	200 MG	50
Copper	2 MG	100
Zinc	15 MG	100

* U.S. Recommended Daily Allowance.

tion, San Francisco, CA), or a 2 tablet dose placebo (cellulose). Treatments were self-administered daily.

Measurements and Laboratory Analysis

Venous blood specimens were collected in vacuum tubes, and the serum frozen at —20°C. White blood cell count, red blood cell count, hemoglobin, hematocrit, mean corpuscular volume, mean cell hemoglobin and mean corpuscular hemoglobin concentration were obtained using automated methods (H-6000, Technicon, Terrytown, NJ). Serum sodium, potassium, chloride, carbon dioxide, urea nitrogen, creatinine, uric acid, total bilirubin, aspartate transaminase, alanine transaminase, gamma glutamyl transferase, alkaline phosphatase, lactate dehydrogenase, calcium, phosphorus, total iron, total protein, albumin, cholesterol and triglyceride were obtained using automated serum analyzers (SMA24, Technicon, Terrytown, NJ). Vitamin B-12, serum folate and red blood cell folate were assayed by radio immunoassay (SimulTRAC, Becton Dickinson, Orangeburg, NY) as were iron binding capacity, iron saturation, transferrin (Iron Binding Capacity Radioassay Kit, Becton Dickinson, Orangeburg, NY), and ferritin (GammaDab, Clinical Assays, Cambridge, MA). Serum magnesium, copper, and zinc were assayed by atomic absorption (Model no. 370, Perkin-Elmer, Norwalk, CT). Serum vitamin A[12], vitamin C[12] and vitamin E[13] were assayed by conventional laboratory methods. Subjects completed semi-monthly 10-question surveys to assess changes in food frequency and medication habits during the study. Three-day fecal and urine collections were made before and after treatments for future study.

Statistical Analyses

One-way analysis of variance was performed on the differences between baseline and post-treatment serum levels using a computer assisted statistical package (Systat Version 1.3, Systat Inc., Evanston, IL). A two-tailed t-test was used to determine significant differences. The chi-square test with the Yates correction for continuity (where $n<5$) was used to deduce significance between frequencies of below-normal results.

RESULTS

Compliance

Tablet counts of the returned bottles suggested that 99% of the tablets were consumed. The semi-monthly surveys revealed that no significant changes ($p>0.05$) in diet or medication habits occurred within either group during the study.

Response of Serum Values to Treatments

Mean serum vitamin C, B-12 and folic acid were significantly increased ($p<0.05$) in the post-treatment supplemented group as compared to placebo (Table 2), and remained within the boundaries of normal. Mean hematological indices and other blood chemistries including indicators of fluid and electrolyte balance, vitamin and mineral status, enzymes, total protein, albumin, total cholesterol and triglyceride did not change significantly ($p>0.05$) for either treatment during the course of the study.

Response of Below-Normal Serum Values to Treatments

The supplemented group had a total of 8 pre-treatment blood chemistry results pertaining to vitamin status which were below normal, while the placebo group

had 2 (Table 3). The number after treatment was significantly decreased ($p<0.025$) to 0 in the supplemented group, and increased to 3 for the placebo group. There were 30 below-normal pre-treatment indicators of iron status in the supplemented group and 16 in the placebo group (Table 3). At post-treatment, the number was significantly reduced ($p<0.005$) to 6 for the supplemented group and 13 for placebo which was not significant ($p>0.05$). The number of below-normal serum copper values remained the same for the placebo and declined insignificantly ($p>0.05$) for the supplemented group.

DISCUSSION

This study shows that in college-age women consuming a cafeteria diet, a daily multivitamin-mineral supplement can significantly increase certain serum indicators of vitamin status. The rise in mean serum vitamin C, B-12, and folate to higher and still normal levels raises the issue of whether such an effect might manifest itself in improved cognitive function, work performance or some other practical indicator which might account for the anecdotal reports of increased vitality frequently cited by supplement takers.[8]

Similarly, the fact that the number of

Table 2 - Serum Values Showing Change With Treatment

Chemistry	Units	Treatment	Pre-Treatment	Post-Treatment
Vitamin C	mg/dl	Placebo	1.01± 0.07	1.07± 0.06[b]
		Supplement	0.96± 0.08	1.31± 0.06[a]
Vitamin B-12	pg/ml	Placebo	448.00±40.39	404.91±42.21[b]
		Supplement	405.71±37.90	430.76±28.57[a]
Folate	ng/ml	Placebo	5.85± 0.51	6.24± 0.82[b]
		Supplement	5.93± 0.56	13.33± 0.85[a]

Data are means ± SEM. Superscripts refer to differences between pre- and post-treatment values (differences are not shown). The differences are significant ($p<0.05$) if they do not share a common superscript.

Table 3 - Below-Normal Serum Values Before and After Treatment.

Chemistry	Placebo		Supplement	
	Before	After	Before	After
RBC Folate	0	1	0	0
Serum Folate	0	1	1	0
Vitamin B-12	0	0	4	0
Vitamin A	1	1	1	0
Vitamin C	1	0	1	0
Vitamin E	0	0	1	0
Hemoglobin	2	1	5	0
Mean Cell HGB	2	0	2	0
Mean Corpus. Vol.	1	1	0	0
Iron Sat. %	2	4	7	2
Serum Ferritin	2	3	7	2
Serum Iron	0	0	2	1
Iron Bind. Capac.	7	4	7	1
Serum Copper	1	1	4	2

individual below-normal serum vitamin and mineral indicators was significantly reduced in the supplemented group suggests some merit to the notion that a daily multivitamin-mineral supplement can serve as a form of «nutrition insurance» - ensuring adequate nutrient intakes and effectively raising below-normal indicators of vitamin-mineral status.

No adverse effects from the long term use of supplements were seen. There was no alteration of hematopoietic function as reflected by the cellular blood values, no alteration in renal function as measured by serum urea nitrogen and creatinine, no hepatotoxicity as measured by serum enzyme levels and no electolyte imbalances. Lipid metabolism as reflected by serum total cholesterol and triglyceride levels remained unchanged.

Vitamin-mineral supplementation is an enormous public health phenomenon with serious economic[14] and clinical implications.[8] The ever-increasing frequency of scientific and popular press reports alluding to the possible benefits of consuming specific nutrients (as opposed to whole foods) suggests it may remain a popular practice. Studies of the nutritional status of the elderly indicate that dietary vitamin and/or mineral insufficiencies are prevalent[15], and support a role for vitamin-mineral supplementation by individuals with compromised caloric or nutrient intakes. However, supplementation is commonly practiced by younger, well-nourished individuals[16] in addition to the elderly. As such, further research with well-nourished individuals is needed to substantiate its possible metabolic and functional benefits.

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Send proof to: Christopher D. Jensen Shaklee Research Center 1992 Alpine Way Hayward, CA 94545 - U.S.A.

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