Reumatol Clin. 2011;**7(4)**:220–223

Reumatología Clínica

www.reumatologiaclinica.org

Original article

The influence of consumption of phytate on the bone mass in posmenopausal women of Mallorca

Ángel A. López-González,[a,*] Félix Grases,[b] Bartolomé Marí,[c] María Teófila Vicente-Herrero,[d] Antonia Costa-Bauzá,[b] Nieves Monroy[e]

[a]*Servicio de Prevención de Riesgos Laborales de GESMA, Palma de Mallorca, Balearic Islands, Spain*
[b]*Institut Universitari d'Investigació en Ciencias de la Salut (IUNICS), Universitat de les Illes Balears, Balearic Islands, Spain*
[c]*Servicio de Medicina del Deporte, Consell Insular de Mallorca, Balearic Islands, Spain*
[d]*Servicio Médico de Correos, Valencia, Spain*
[e]*Servicio de Prevención de Riesgos Laborales, Administración del Govern de les Illes Balears, Balearic Islands, Spain*

ARTICLE INFO

Article history:
Received March 1, 2010
Accepted July 7, 2010

Keywords:
Postmenopausal osteoporosis
Phytate
Densitometry

ABSTRACT

Basis: Osteoporosis is a serious health problem in the population, mainly for postmenopausal women. Therefore, it is important to develop programs to decrease prevalence. The main objective of this study is to determine the influence of phytate consumption on bone mineral density.
Patients and method: The bone mineral density was evaluated in postmenopausal women by means of dual X-ray double energy absorptiometry for calcaneous (C), lumbar spine (LS) and femoral neck (FN). The results obtained were related to the consumption of phytate by means of a dietary questionnaire.
Results: In the three different areas (C, LS, FN) we observed significantly higher values of T-score in women that consumed adequate amounts of phytate as opposed to those that did not, (C 0.1 vs −0.5, LS −1.2 and −2.5 and FN −0.2 and −1.2). There is also an increase in the T-score as more phytate is consumed, up to a maximum of two times a week (C −0.7 in non consumers, −0.2 in those that consume phytate once a week and 0.2 in those that consume phytate twice a week; LS −2.8, −1.7 and 1.1 and finally, CF −1.3, −0.6 and −0.1).
Conclusion: The results obtained seem to indicate that the adequate consumption of phytate may play an important role in the prevention of bone mineral density loss in postmenopausal women.

Influencia del consumo de fitato sobre la masa ósea en mujeres posmenopáusicas de Mallorca

Palabras clave:
Osteoporosis posmenopáusica
Fitato
Densitometría

RESUMEN

Fundamento: La osteoporosis supone un gran problema de salud para la población, especialmente para el colectivo de mujeres posmenopáusicas, siendo por ello importante que se establezcan políticas preventivas que hagan disminuir su prevalencia. El objetivo de este estudio es valorar la influencia que tiene el consumo de fitato en los niveles de densidad mineral ósea.
Población y método: Se calcula la masa ósea en mujeres posmenopáusicas empleando DEXA de calcáneo (C), columna lumbar (CL) y cuello de fémur (CF) y se relacionan estos valores con el consumo de fitato determinado mediante encuesta alimentaria.
Resultados: En las tres localizaciones se observan mayores valores de T-score en las mujeres que consumen fitato en cantidades adecuadas frente a las que no lo consumen (C: 0,1 frente a −0,5; CL: −1,2 y −2,5, y CF: −0,2 y −1,2). También aumenta el T-score a medida que lo hace la cantidad de fitato consumida, hasta un máximo de 2 veces a la semana (C: −0,7 en no consumidores, −0,2 en consumidores de fitato de una vez por semana y 0,2 en los que consumen 2 veces por semana; CL −2,8, −1,7 y −1,1, respectivamente, y finalmente CF: −1,3, −0,6 y −0,1, respectivamente).
Conclusiones: Los resultados obtenidos parecen indicar que el consumo regular de fitato puede tener un papel importante en la prevención del déficit de masa ósea en mujeres posmenopáusicas.

* Corresponding author.
E-mail address: angarturo@gmail.com (Á.A. López-González).

1699-258X/$ - see front matter

Introduction

Osteoporosis can be defined as a disease of the skeleton characterized by a compromise of bone resistance which leads to a greater risk of fracture.[1]

It is considered the most common metabolic disease,[2,3] although its real prevalence is difficult to establish because it is generally asymptomatic until complications appear. Prevalence differs according to each author; Díaz-Curiel et al[4] in a study performed on the Spanish population considered that 9,09% of women between 50 and 59 years of age have osteoporosis, ascending to 40% in those aged 70 to 79. However, Melton,[5] in north American women, presented lower prevalence values: 7,6% for women aged 50 to 59 and 25% for those 70 a 79.

Bone densitometry with DEXA is considered the ideal method[6] to precisely determine bone mass in different body localizations as well as predicting long-term risk for fracture.

The consumption of phytate has classically been associated with a reduction in bone mass values; Mellanby[7] showed that dogs fed with a phytate rich diet had a reduction in the intestinal absorption of calcium that led to rickets. When sodium phytate (phytic acid) was substituted calcium-magnesium phytate (phytine), a salt naturally found in vegetable seeds, and balanced diets used, no abnormal effects were seen.[8]

The real biologic action of phytate was recently discovered when the technical difficulties in quantifying it in live organisms were overcome. In 1996, the presence of phytate in human urine was demonstrated.[9]

Its levels show a direct and proportional relationship with the type of diet received, because the organism is not capable of synthesizing it in appreciable quantities. Phytate is found in elevated concentrations in cereals, legumes, dry fruit and whole grains in general. Animal studies have found that maximal plasma levels are reached when the diet contains 0,12% of phytin[10] and that consumption over 20,9 mg/kg lead to the maximal urinary excretion; in addition, further increases in consumption do not lead to increases in urinary excretion.[11] In order to reach these maximum levels of urinary excretion, consuming phytin rich foods at least three times a week is needed.

The effects of the consumption of phytin on renal lytiasis has been known for some years[12-15] as well as its role on cardiac calcifications[16] and studies have recently described how it acts on bone and its role in osteoporosis.[17]

Making a biochemical analogy between phytin and bisphosphonates, it has been shown that preincubation of phytin in an in vitro solution with hydroxyapatite was capable of inhibiting the dissolution of hydroxyapatite by acid in a concentration dependent form. The effect of phytin inhibiting the hydroxyapatite solution was similar to that seen with alendronate and superior to the one obtained with etidronate.[18] This data led to the hypothesis that an adequate consumption of phytin may play a role in preventing osteoporosis. A recently published study by our group[19] shows that the consumption of phytate improves bone mass and protects against other classic risk factors for osteoporosis. The objective of this study is to evaluate the influence that the consumption of phytin has on the bone mass levels in a postmenopausal women.

Patients and methods

A double densitometric study was carried out in a group of postmenopausal women from Mallorca, aged 47 to 60. All of them (443 women) underwent peripheral calcaneal DEXA densitometry and a randomly selected sample (45.82% of total, 203 women) underwent lumbar spine and femoral neck densitometry. Although not all participants underwent both procedures, the elevated percentage in which this was performed and its random nature allows us to extrapolate the results to the whole study population.

Phytate consumption was determined in all of the cases through a questionnaire.

This study is the subanalysis of another19 performed by us in 1.473 persons (983 women and 490 men) in which these 443 women have been considered for further analysis.

Inclusion and exclusion criteria

Normal postmenopausal women were considered a general inclusion criterion, excluding, after clinical and laboratory review, all of those who had a disease that could influence bone mineralization or who took drugs that could modify it. We also excluded cases of natural premature menopause or surgical menopause before 45 years of age, the presence of prosthesis or other artifacts in the measurement localizations, lesions, fractures or calcifications of the lumbar aorta, important scoliosis with vertebral morphologic alterations, those with a rotational component on the vertebrae and feet deformities which could impede an adequate position of the talus.

Bone density measurements

All of the women included in the study underwent a peripheral right calcaneus DEXA densitometry, in other words the dominant calcaneal bone in the Spanish population. A percentage of them (45.82%) also underwent lumbar spine (L2, L3, L4) and proximal right femur densitometry, once again the dominant side of our population. We obtained T score values, expressing them as mean between L2 and L4, in the lumbar spine and in the femoral neck and calcaneal areas.

A PIXI Lunar DEXA was employed for calcaneal measurements and a Norland XR-46 (Norland Medical Systems, Inc) was employed for the lumbar spine and femoral neck measurements. One machine was used for all measurements.

Phytate consumption measures

Phytate consumption was determined through a self-reported questionnaire, using an un-validated survey proposed by our group, which reflected the consumption of phytate-rich foodstuffs. The survey was applied twice, when the calcaneal densitometry was carried out and when the lumbar spine and femoral neck study was performed. Prior studies by our group establish a good correlation between the stated consumption and the levels obtained in the urine and other tissues.

In order to establish the consumption of phytate we took into account the three main food groups which provide a significant amount of dietary phytate: legumes, cereals and dry fruit. To consider an intake as adequate we determined that it should be at least twice a week for one of the foodstuffs in these groups. In prior studies[10,11,14] by researchers at the Institut Universitari d'investigació en Ciencies de la Salut (IUNICS) it was determined that with the consumption of phytate rich food at least twice a week, one could detect maximum levels of phytate both in the urine as in other tissues. Under this threshold, the tissue value was proportional. Because these studies had different cut-points in phytate consumption, three groups were established: non-consumers, those ingesting phytate only once a week and those consuming it twice a week.

The influence in the consumption of phytate on the bone mineral density was established twofold: on the one hand, an adequate or inadequate consumption and, on the other, the number of days a week that it is consumed.

Table 1
Mean age and years of menopause according to phytate consumption

Phytate consumption	Age	SD	Years since menopause
Adequate	53.7	4.3	7.6
Inadequate	53.2	4.4	7.9
Nonea	52.8	4.7	8.1
Once	53.3	4.5	8.3
Twice	54.1	4.6	7.7
Three or more	53.6	4.7	7.9

[a]Number of times a week phytate rich food was consumed.

Statistical analysis

We calculated sample size through estimation, with 197 women being necessary for analysis.

To evaluate differences in bone mass between the groups we used variance analysis.

To evaluate agreement both for the measurements of both types of densitometry as for the two food surveys, we used Cohen's kappa test.

Results

The study was performed in 433 women using calcaneus densitometry and lumbar spine and femoral neck determination in 203.

The degree of agreement between measurements by both densitometers, estimated using Cohen's kappa was very high, 0.8215 between calcaneus and lumbar spine and 0.8123 between calcaneus and femoral neck.

The degree of agreement in the self-reported surveys of phytate consumption was considered very high, with a kappa of 0.9745.

No differences in the consumption of phytate by women were found with regard to age or the years since menopause, as shown on Table 1.

Consumption of phytate and bone mineral density

According to quantity of phytate consumed

In the calcaneus, T-scores increased according to consumption of phytate, being –0.7 (SD: 1.3) when none was consumed and 0.2 (SD: 1) when consumed three times a week or more.

A similar situation occurred on the lumbar spine (women with no consumption had values of –2.8 and an SD of 0.7 and those consuming three or more times a week –1 with an SD of 1.3) and the femoral neck (–1.3 SD 1.2 in non consumers and –0.1 SD 1 in those consuming three times a week at least).

Complete data regarding bone mass when no consumption, twice a week and three times a week is shown in Figure 1 and Table 2.

Differences in bone mass were statistically significant in the three localizations (calcaneus, lumbar spine and femoral neck) between those with no consumption and those with consumption once, twice or three times a week, as well as in those consuming once and those consuming twice or three times a week. Na differences were appreciated between those consuming twice and those consuming phytate three or more times a week.

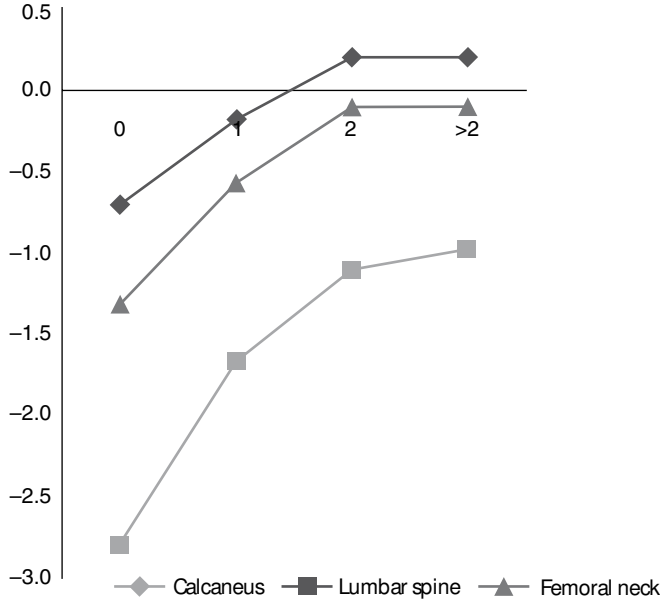

Figure 1. T-score progression in the different localizations according to the weekly frequency of phytate consumption.

According to adequate or inadequate phytate consumption

In the calcaneus, lumbar spine and femoral neck, the T-score values were higher in women with adequate consumption of phytate vs those without it; in the three cases, differences were statistically significant. Complete data is presented on Table 3 and Figure 2.

Discussion

In light of the results of the study it appears that phytate consumption improves bone mineral density levels in postmenopausal women in the three locations studied. This improvement is clear when comparing women who consume adequate levels to those who didn't, whereas if we take into account the amount of phytate consumed, there is a clear elevation of bone mineral density when consumption is twice a week, as well as higher levels derived from three intakes a week. This data is consistent with studies on the pharmacokinetics of phytate.[10,11]

Comparisons to previous studies cannot be made with the results obtained in our study because similar studies do not exist in the literature in any scientific publication or database, so this can be considered as the first study on the relationship between phytate intake and bone mineral density in postmenopausal women. Information is available on the effect of phytate intake in oophorectomized rats,[20] which noted that those which consumed adequate amounts of phytate had better bone mineral density levels.

This behavior of phytate, apparently surprising when you consider that phytate has been considered as an anti-nutrient, is easily explained if one takes into account that this molecule, its structural features, can be considered as an analogue of bisphosphonate drugs whose activity as protectors in osteoporosis is well known.[21,22]

Table 2
T-scores in the different localizations according to consumption of phytate

Phytate consumption/week	T-score	Calcaneus SD	n	T-score	Lumbar spine SD	n	T-score	Femur SD	n
0	−0.7	1.3	49	−2.8	0.7	39	−1.3	1.2	39
1	−0.2	0.9	115	−1.7	1.2	45	−0.6	0.8	45
2	0.2	1.2	143	−1.1	1.6	52	−0.1	1.4	52
>2	0.2	1	136	−1	1.3	67	−0.1	1	67

Table 3
T-scores in the different localizations according to adequate or inadequate phytate consumption

Adequate phytate consumption	T-score	SD	n	P
Calcaneus				
Yes	0.1	1.1	225	.0005
No	−0.5	1.3	218	
Lumbar spine				
Yes	−1.2	1.5	106	.0009
No	−2.5	1	97	
Femoral neck				
Yes	−0.2	1.2	106	.0003
No	−1.2	1.1	97	

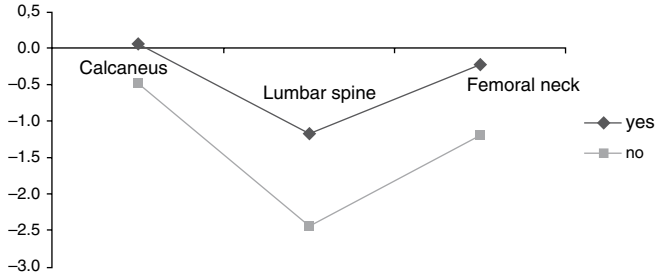

Figure 2. T-scores on the different localizations according to adequate or inadequate phytate consumption.

Although in this study we have not assessed other risk factors besides menopause, another study from our group[17,19] analyzed the protective role of phytate compared to other risk factors, including menopause and noted that in all risk factors, adequate intake of phytate improved bone mass significantly.

This study's most important limitations are the fact that the consumption of phytate is established by self-reporting by the persons involved in the study and not based on analytical parameters such as urine phytate excretion. We tried to minimize this limitation on the dietary survey by applying it on two occasions with an interval of 3 months. The degree of agreement obtained in the self-assesment was very high (0.9745).

To confirm the above results we suggest that there should be a similar study aiming to determine phytate consumption through analytical methods such as the level of phytic acid in 2 h urine excretion.

Conflict of interest

The authors declare no conflict of interest.

References

1. NIH Consensus Development Panel. Osteoporosis Prevention, Diagnosis, and Therapy. JAMA. 2000;285:785-95.
2. Eisman JA. Genetics of osteoporosis. Endocr Rev. 1999;20:788-804.
3. Paulino J. Osteoporosis: importancia, epidemiología y manifestaciones clínicas. Medicine. 2000;8:15-22.
4. Díaz-Curiel M, García JJ, Carrasco JL, Honorato J, Pérez-Cano R, Rapado A, et al. Prevalencia de osteoporosis determinada por densitometría en la población femenina española. Med Clin (Barc). 2001;116:86-8.
5. Melton LJ. How many women have osteoporosis now?. J Bone Miner Res. 1995;10:175-7.
6. Persi P. Densitometría ósea 2000. Med Clin (Barc). 2000;114:540-2.
7. Mellanby E. Rickets-producing and anticalcifying action of phytate. J Physiol. 1949;109:488-533.
8. Grases F, Simonet BM, Perelló J, Costa-Bauzá A, Prieto RM. Effect of Phytate on element bioavailability in the second generation rats. J Trace Elem Med Biol. 2004;17:229-34.
9. Grases F, Llobera A. Determination of phytic acid in urine by ICP atomic emission spectrometry. Analytical Letters. 1996;29:1193-9.
10. Grases F, Simonet BM, Prieto RM, March JG. Dietary phytate and mineral bioavailability. J Trace Elem Med Biol. 2001;15:221-8.
11. Grases F, Simonet BM, Vucenik I, Prieto RM, Costa-Bauzá A, March JG, et al. Absorption and excretion of orally administered inositol hexaphosphate IP6 or phytate in humans. BioFactors. 2001;15:53-61.
12. Grases F, Costa-Bauzá A. Phytate is a powerful agent for preventing calcifications in biologicals fluids: usefulness in renal lithiasis treatment. Anticancer Res. 1999;19:3717-22.
13. Grases F, Costa-Bauzá A, Königsberger E, Königsberger LC. Kinetic versus thermodynamic factors in calcium renal lithiasis. Int Urol Nephrol. 2000;32: 19-27.
14. Grases F, Simonet BM, March JG, Prieto RM. Inositol hexakisphosphate in urine: the relationship between oral intake and urinary excretion. BJU Int. 2000;85: 138-42.
15. Grases F, March JG, Prieto RM, Simonet BM, Costa-Bauzá A, García-Raja A, et al. Urinary phytate in calcium oxalate stone formers and healthy people. Dietary effects on phytate excretion. Scand J Urol Nephrol. 2000;34:162-4.
16. Grases F, Sanchos P, Perello J, Isern B, Prieto RM, Fernández-Palomeque C, et al. Phytate (Myo-inositol hexakisphosphate) inhibits cardiovascular calcifications in rats. Frontiers in Bioscience. 2006;11:136-42.
17. López-González AA. Influencia de diferentes factores de riesgo incluyendo el myo-inositol hexafosfato cálcico-magnésico en los niveles de densidad mineral ósea en trabajadores de Mallorca. Tesis Doctoral; 2007.
18. Grases F, Sanchis P, Costa-Bauzá A, Perelló J. Phytate (Myo-inositol hexakisphosphate) inhibits hydroxyapatite dissolution [Under preparation].
19. López-González AA, Grases F, Roca P, Marí B, Vicente-Herrero MT, Costa-Bauzá A. Phytate (Myo-inositol hexaphosphate) and risk factors for osteoporosis [in press]. J Med Food. 2008;11:747–52.
20. Grases F, Sanchis P, Perelló J, Prieto RM, López-González AA. Effect of phytate (Myo-inositol hexaphosphate) on bone characteristics in ovariectomized rats. J Med Food. 2010 [in press].
21. Fleisch H. Development of bisphosphonates. Breast Cancer Res. 2002;4:30-4.
22. Fleisch H. Bisphosphonates in osteoporosis. Eur Spine J. 2003;12:142-6.