Maturitas 70 (2011) 333–338

Contents lists available at SciVerse ScienceDirect

Maturitas

journal homepage: www.elsevier.com/locate/maturitas

Review

Soy isoflavones for osteoporosis: An evidence-based approach

Kyoko Taku[a,*], Melissa K. Melby[b], Nobuo Nishi[c], Toyonori Omori[d], Mindy S. Kurzer[e]

[a] Section of Biostatistical Research, Center for International Collaboration and Partnership, National Institute of Health and Nutrition, 1-23-1 Toyama, Shinjuku-ku, Tokyo 162-8636, Japan
[b] Department of Anthropology, University of Delaware, Newark, DE 19716, USA
[c] Center for International Collaboration and Partnership, National Institute of Health and Nutrition, Tokyo 162-8636, Japan
[d] Department of Health Care Policy and Management, Nagoya City University Graduate School of Medical Sciences, Nagoya 467-8601, Japan
[e] Department of Food Science and Nutrition, University of Minnesota, St. Paul, MN 55108, USA

ARTICLE INFO

Article history:
Received 24 August 2011
Accepted 2 September 2011
Available online 9 September 2011

Keywords:
Soy isoflavones
Osteoporosis
Bone density
Bone turnover markers
Menopausal women
Meta-analysis

ABSTRACT

Effects of soy isoflavones on osteoporosis remain unclear. This review aimed to clarify the effect of soy isoflavones on bone mineral density (BMD) and turnover markers in menopausal women. PubMed and the Cochrane Library were searched in July 2011 for relevant meta-analyses of randomized controlled trials evaluating effects of soy isoflavones on BMD and bone turnover markers. Three meta-analyses evaluated the effects of soy isoflavones on lumbar spine, total hip, femoral neck, and trochanter BMD. Soy isoflavones significantly improved lumbar spine BMD in a moderate manner, but did not affect total hip, femoral neck, and trochanter BMD in menopausal women. Ingestion of soy isoflavones for six months appeared to be enough to exert a beneficial effect on lumbar spine BMD. Two meta-analyses evaluated the effects of soy isoflavones on a bone resorption marker (urine deoxypyridinoline) and two formation markers (serum alkaline phosphatase and osteocalcin). Soy isoflavones significantly decreased urine deoxypyridinoline in a moderate manner, but did not affect serum alkaline phosphatase and osteocalcin in menopausal women. Soy isoflavones may prevent postmenopausal osteoporosis and improve bone strength thus decreasing risk of fracture in menopausal women by increasing lumbar spine BMD and decreasing bone resorption marker urine deoxypyridinoline. Further studies are needed to address factors affecting the magnitude of the beneficial effects of soy isoflavones and to assess the possible interactions between soy isoflavones and anti-osteoporosis drugs, and to verify effects on BMD of other skeletal sites and other bone turnover markers.

Contents

1. Introduction

Osteoporosis is a major health problem in postmenopausal women, who experience sharp decreases in estrogen concentrations that lead to an increased rate of bone remodeling [1,2]. The increased bone remodeling is associated with both decreased bone mineral density (BMD) and increased risk of fracture [3]. The yearly decline in BMD of lumbar spine and hip in postmenopausal women is reported to be at least 1% and up to 2.4% [1,4]. Together with BMD, some bone turnover markers have been considered to be biomarkers for fracture risk [5]. Bone turnover markers can be used for the diagnosis and evaluation of therapy effects on osteoporosis [6], and include bone resorption markers (e.g. urine deoxypyridinoline

* Corresponding author. Tel.: +81 3 3203 5721; fax: +81 3 3202 3278.
E-mail address: takuk@nih.go.jp (K. Taku).

0378-5122/$ – see front matter © 2011 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.maturitas.2011.09.001

Table 1
Characteristics of five meta-analyses clarifying effects of soy isoflavones on bone mineral density (BMD) and bone turnover markers.

Studies[a]	RCTs[a]	Participants[a]	Intervention[a]	Duration	Heterogeneity[b]	Overall effects (95% CI)[c]		Publication bias
						Fixed effect model	Random effects model	
Ma et al. [28]								
Lumbar spine BMD	10 (6 ISP, 4 SIE)	612 (515 post, 97 peri)	4.4–150 mg/d SI vs. control	3–24 months	Unknown	20.6 (4.5–36.6) mg/cm^2, $P = 0.01$	Not shown	Not significant
Liu et al. [27]								
Lumbar spine BMD	10 (5 ISP, 4 SIE, 1 soymilk)	896 (868 post, 28 pre)	87 (40–200) mg/d SI vs. control	12–24 months	$P < 0.001$; $I^2 = 70\%$	Not shown	4.1 (−1.6 to 9.8) mg/cm^2/year, $P = 0.16$; or 0.4%	Not significant
Total hip BMD	5 (3 ISP, 2 SIE)	494 post	40–99 mg/d SI vs. control	12 months	$P = 0.92$; $I^2 = 0\%$	2.5 (−0.5 to 5.4) mg/cm^2/year, $P = 0.10$; or 0.3%	Not shown	Not significant
Femoral neck BMD	6 (3 ISP, 3 SIE)	536 (508 post, 28 pre)	40–200 mg/d SI vs. control	12–15 months	$P = 0.03$; $I^2 = 59\%$	Not shown	−1.5 (−7.2 to 4.3) mg/cm^2/year, $P = 0.62$; or −0.2%	Not significant
Taku et al. [29]								
Lumbar spine BMD	11 (SIE)	1240 (1164 post, 76 MW)	82 (47–114) mg/d SIA vs. control	6 months to 1 year	$P < 0.001$	12.1 (9.8–14.3) mg/cm^2, $P < 0.001$; or 1.5% (1.2%–1.7%), $P < 0.001$	20.3 (7.6–32.9) mg/cm^2, $P = 0.002$; or 2.4% (0.9%–3.8%), $P = 0.001$	Not significant
Femoral neck BMD	7 (SIE)	868 post	76 (47–150) mg/d SIA vs. control	6 months to 1 year	$P < 0.001$	Not shown	10.2 (−3.7 to 24.2) mg/cm^2, $P = 0.15$; or 1.5% (−0.5% to 3.5%), $P = 0.15$	Not shown
Total hip BMD	5 (SIE)	420 (344 post, 76 MW)	74 (47–110) mg/d SIA vs. control	6 months to 1 year	$P \geq 0.1$	2.5 (−1.4 to 6.3) mg/cm^2, $P = 0.21$; or 0.1% (−0.5% to 0.6%), $P = 0.86$	Not shown	Not shown
Trochanter BMD	5 (SIE)	419 post	85 (47–150) mg/d SIA vs. control	6 months to 1 year	Unknown	Not shown	−0.4 (−6.6 to 5.8) mg/cm^2, $P = 0.90$; or −0.1% (−1.2% to 1.0%), $P = 0.91$	Not shown
Ma et al. [32]								
Urine DPD	9 (5 ISP, 4 SIE)	432 (366 post, 66 peri)	37.3–118 mg/d SI vs. control	4–48 weeks	Unknown	Not shown	−2.08 (−3.82 to −0.34) nmol/mmol, $P < 0.05$	Not significant
Urine BAP	5 (3 ISP, 2 SIE)	248 post	41.9–114 mg/d SI vs. control	12–48 weeks	Unknown	Not shown	1.48 (0.22–2.75) μg/L, $P < 0.05$	Not shown
Taku et al. [33]								
Urine DPD	10 (3 SF, 7 SIE)	887 (864 post, 23 peri)	56 (14–114) mg/d SIA vs. placebo	10 weeks to 12 months	$P = 0.00001$; $I^2 = 73\%$	−16.9% (−22.1% to −11.7%), $P < 0.00001$	−18.0% (−28.4% to −7.6%), $P = 0.0007$	Not significant
Serum BAP	10 (4 SF, 6 SIE)	1210 post	84 (42–114) mg/d SIA vs. placebo	3–12 months	$P < 0.0001$; $I^2 = 98\%$	12.0% (10.5% to 13.6%), $P < 0.00001$	8.0% (−4.2% to 20.2%), $P = 0.20$	Not significant
Serum OC	8 (1 SF, 7 SIE)	380 (357 post, 23 peri)	73 (38–110) mg/d SIA vs. placebo	6 weeks to 12 months	$P = 0.002$; $I^2 = 69\%$	4.6% (−1.0% to 10.2%), $P = 0.11$	10.3% (−3.1% to 23.7%), $P = 0.13$	Not significant

[a] BAP, bone alkaline phosphatase; DPD, deoxypyridinoline; OC, osteocalcin (or bone gamma-carboxyglutamate protein, BGP); RCTs, randomized controlled trials; ISP, isolated soy protein; SIE, soy isoflavone extract; SF, soy foods containing isoflavones; MW, menopausal women; peri, post, and pre, peri-, post-, and pre-menopausal women, respectively; SI, soy isoflavones, SIA, soy isoflavones (aglycone equivalents).

[b] $P < 0.1$ was considered significant; the I^2 statistic (0%–40%: might not be important; 30%–60%: may represent moderate heterogeneity; 50%–90%: may represent substantial heterogeneity; 75%–100%: considerable heterogeneity) was used for quantifying inconsistency across studies, which describes the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (chance) [35].

[c] When there was significant heterogeneity across included studies, the results based on the random effects model incorporating heterogeneity were preferably adopted [35]. A random effects model involves an assumption that the effects being estimated in the different studies are not identical, but follow some distribution. The model represents our lack of knowledge about why real, or apparent, treatment effects differ by considering the differences as if they were random.