

ESTROGEN

Choline

Estrogen stimulates the breakdown of phosphatidylcholine (cell membrane) so those with low estrogen (postmenopausal women) require more choline; Detoxifies excess estrogen via methylation pathway.^{1,32,33}

Cysteine

Prevents oxidation of estrogen into a dangerous form that causes breast cancer.^{29,30,31}

Zinc

Estrogen lowers risk of zinc deficiency; Zinc dependent proteins metabolize estrogen.^{26,27,28}

Magnesium

Cofactor for the enzyme that removes toxic forms of estrogen (catechol-O-methyltransferase); Estrogen alters magnesium levels throughout menstrual cycle.^{1,24,25,26}

Selenium

Helps metabolize the biologically active estrogen (estradiol) to an inactive form (estrone).^{18,19}

Calcium

Calcium-D-glucarate lowers estradiol levels; Helps breakdown estrogen in the liver and convert it to a less toxic form.^{1,20,21}

Folate

Deficiency reduces estrogen levels; Excess folate is linked to some types of estrogen-related breast cancer; Detoxifies excess estrogen via methylation pathway; Regulates estrogen's effect on genes.^{1,2,3}

Vitamin A

Helps metabolize the biologically active estrogen (estradiol) to an inactive form (estrone).^{18,19}

Vitamin B6

Protects genes from estrogen-induced damage thus lowering risk of hormone related cancers; Detoxifies excess estrogen via methylation pathway; Estrogen-based oral contraceptives cause B6 deficiency.^{4,5,6,7}

Vitamin D

Regulates synthesis of estradiol and estrone; Enhances estrogen's protective effect on bones.^{8,9,10}

Vitamin C

Increases the most potent estrogen (estradiol) in women on hormone therapy; Lowers aromatase (enzyme that converts testosterone to estrogen) in ovaries.^{11,12,13}

Vitamin K

Inhibits estrogen activity by binding to estrogen receptors; Lowers the ratio of estradiol (strong estrogen) to estrone (weaker estrogen).^{14,15}

Vitamin E

Deficiency impairs estrogen detoxification pathway; Some forms of vitamin E inhibit estrogen action, especially in breast tissue; Low levels linked to higher estrogen.^{1,16,17}

REFERENCES

- ¹Hall D. Nutritional influences on estrogen metabolism. *Appl Nutr Sci Rep* 2001;1-8
- ²Ericson U, Borgquist S., Ivarsson M et al. Plasma Folate Concentrations Are Positively Associated with Risk of Estrogen Receptor {beta} Negative Breast Cancer in a Swedish Nested Case Control Study. *J Nutr* 2010; 140:1661-1668.
- ³Wallock-Montellius L, Villanueva J, Chapin R et al. Chronic ethanol perturbs testicular folate metabolism and dietary folate deficiency reduces sex hormone levels in the Yucatan micropig. *Biol Reprod* 2007;76:455-465
- ⁴Allgood V, Cidlowski J. Vitamin B6 modulates transcriptional activation by multiple members of the steroid hormone receptor superfamily. *J Biol Chem* 1192;25:3819-3824
- ⁵Zhu B. Medical hypothesis: hyperhomocysteinemia is a risk factor for estrogen-induced hormonal cancer. *Int J Oncol* 2003;22:499-508
- ⁶Tully D, Allgood V, Cidlowski J. Modulation of steroid receptor-mediated gene expression by vitamin B6. *FASEB J* 1994;8:343-349
- ⁷el-Sahwy S, Osman M, el-Tabakh S et al. Effect of the administration of vitamin B6 at two levels of intake on xathurenic acid excretion among oral contraceptive pill users. *J Egypt Public Health Assoc* 1988;63:393-405
- ⁸Somjen D. Vitamin D modulation of the activity of estrogenic compounds in bone cells in vitro and in vivo. *Crit Rev Eukaryot Gene Expr* 2007;17:115-147
- ⁹Parikh G, Varadinova M, Suwandhi P et al. Vitamin D regulates steroidogenesis and insulin-like growth factor binding protein-1 (IGFBP-1) production in human ovarian cells. *Horm Metab Res* 2010;42:754-757.
- ¹⁰Villaggio B, Soldano S, Cutolo M. 1,25-dihydroxyvitamin D3 downregulates aromatase expression and inflammatory cytokines in human macrophages. *Clin Exp Rheumatol* 2012;30:934-938.
- ¹¹Vihtamaki T, Parantainen J, Koivisto M et al. Oral ascorbic acid increases plasma oestradiol during post-menopausal hormone replacement therapy. *Maturitas* 2002;25:129-135.
- ¹²Wu X, Iguchi T, Itoh N et al. Ascorbic acid transported by sodium-dependent vitamin C transporter 2 stimulates steroidogenesis in human choriocarcinoma cells. *Endocrinology* 2008;149:73-83.
- ¹³Tsuji M, Ito Y, Terado N et al. Ovarian aromatase activity in scorbutic mutant rats unable to synthesize ascorbic acid. *Acta Endocrinol* 1989;121:595-602.
- ¹⁴Otsuka M, Kato N, Ichimura T et al. Vitamin K2 binds 17beta-hydroxysteroid dehydrogenase 4 and modulates estrogen metabolism. *Life Sci* 2005;76:2473-2482.
- ¹⁵Jung J, Ishida K, Nishihara T. Anti estrogenic activity of fifty chemicals evaluated by in vitro assays. *Life Sci* 2004;74:3065-3074
- ¹⁶Lee H, Ju J, Paul S et al. Mixed tocopherols prevent mammary tumorigenesis by inhibiting estrogen action and activating PPAR-gamma. *Cancer Res* 2009;15:4242-4249
- ¹⁷Hsieh T, Wu J. Suppression of cell proliferation and gene expression by combinatorial synergy of EGCG, resveratrol and gamma-tocotrienol in estrogen receptor-positive MCF-7 breast cancer cells. *Int J Oncol* 2008;33:851-859
- ¹⁸Cheng Y, Yin P, Xue et al. Retinoic acid (RA) regulates 17beta-hydroxysteroid dehydrogenase type 2 expression in endometrium: interaction of RA receptors with specificity protein (SP) 1/SP3 for estradiol metabolism. *J Clin Endocrinol Metab* 2008;93:1915-1923.
- 19Zhu S, Li Y, Li H et al. Retinoic acid (RA) regulates 17beta-hydroxysteroid dehydrogenase type 2 expression in endometrium: interaction of RA receptors with specificity protein (SP) 1/SP3 for estradiol metabolism. *J Clin Endocrinol Metab* 2008;93:1915-1923.
- 20 Monograph: Calcium-D-Glucarate as a chemopreventive agent in breast cancer. *Isr J Med Sci* 1995;31:101-105.
- 21Heerdt A, Young C, Borgen P. Calcium glucarate as a chemopreventive agent in breast cancer. *Isr J Med Sci* 1995;31:101-115.
- 22Zhou X, Smith A, Failla M et al. Estrogen status alters tissue distribution and metabolism of selenium in female rats. *J Nutr Biochem* 2012;23:532-538.
- 23Ha E, Smith A. Selenium-dependent glutathione peroxidase activity is increased in healthy postmenopausal women. *Biol Trace Elem Res* 2009;131:90-95.
- 24Muneyvirici-Delale O, Nacharaju V, Altura B. Sex steroid hormones modulate serum ionized magnesium and calcium levels throughout the menstrual cycle in women. *Fertil Steril* 1198;69:958-962.
- 25Butterworth M, Lau S, Monks T. 17 beta-Estradiol metabolism by hamster hepatic microsomes. Implications for the catechol-O-methyl transferase-mediated detoxication of catechol estrogens. *Drugs Metab Dispos* 1996;24:588-594.
- 26Bureau I, Anderson R, Arnaud J et al. Trace mineral status in post menopausal women: impact of hormonal replacement therapy. *J Trace Elem Med Biol* 2002;16:9-13.
- 27Herzberg M, Lusky A, Blonder J. The effect of estrogen replacement therapy on Zinc in serum and urine. *Obstet Gynecol* 1996;87:1035-1040.
- 28FavierA. The role of zinc in reproduction. Hormonal mechanisms. *Biol TraceElemRes* 1992;32:363-382.
- 29Cavalieri E, Rogan E. Unbalanced metabolism of endogenous estrogens in the etiology and prevention of human cancer. *J Steroid Biochem Mol Biol* 2011;125:169-180.
- 30Venugopal D, Zahid M, Mailander P et al. Reduction of estrogen-induced transformation of mouse mammary epithelial cells by N-acetylcystein. *J Steroid Biochem Mol Biol* 2008;109:22-30.
- 31Zahid M, Saeed M, Ali M et al. N-acetylcysteine blocks formation of cancer-initiating estrogen-DNA adducts in cells. *Free Radic Biol Med* 2010;49:392-400.
- 32Fischer L, da Costa K, Kwock L et al. Dietary choline requirements of women: effects of estrogen and genetic variation. *Am J Clin Nutr* 2010;92:1113-1119.
- 33Corbin K, Zeisel S. The nutrigenetics and nutrigenomics of the dietary requirement for Choline. *Prog Mol Biol Transl Sci* 2012;108:159-177.

Additional references at <http://www.spectracell.com/online-library-mnt-adhd-abstracts/>