1. INTRODUCTION

Trace element supplementation projects in women bring up specific problems. These are a reflection of the action of hormones on the metabolism of trace elements. Conversely the hormonal metabolism is dependent, at many steps, on various trace elements and hence can be modified by nutritional deficiencies. The adequacy of trace element intake is most important during the major hormonal changes that rhythm women’s life.

2. RELATIONSHIP BETWEEN TRACE ELEMENTS AND FEMALE HORMONES

Trace elements can act at all levels of production, action and regulation of hormones (1). In the hypothalamic-pituitary axis, zinc facilitates the synthesis and activation and copper is involved in the terminal amidation of peptides. Zinc also regulates the secretion of prolactin by the pituitary gland (2) and copper in a chelated form, acts on a peptidyl amidase to modulate the release of LHRH (3). The administration of copper to the rat stimulates the release of GnRH and LH (4). Trace elements act on several steps in the synthesis of estrogens. Steroid hormones synthesis is dependent on zinc at the level of 3 and 17 hydroxy-dehydrogenases, and on iron at the level of hydroxylases. Zinc by desaturases, iron by oxygenase and selenium modulate the synthesis of prostaglandins, that have a major influence on the onset of labor (5).

Finally trace elements are necessary for the activity of peripheral receptors that allow the expression of hormonal message. Zinc modulates the form of the zinc-finger proteins of the estrogen receptors, which are cytosolic proteins migrating to the nucleus of the cell under
the influence of the hormones to act as transcription factors. Zinc deficient rats present reduced estrogen sensitivity in the absence of any modification in the number of receptors (6). It is worth mentioning that copper also promotes estrogen binding to the protein receptor in the cytosolic compartment (7). The same effect occurs with progesterone, whose receptor functions according to the same model. Zinc gives also an active form to the LH receptors inside the cell membrane.

Conversely female hormones influence the metabolism of trace elements. Estrogens, and or progesterone strongly modify copper metabolism, increasing copper concentrations in serum, liver and kidneys. Estrogen raises serum transferrin and iron levels, by increasing the transcription of the transferrin gene. There are conflicting results on the effects of sex hormones on zinc metabolism, but most studies demonstrate a decrease in serum zinc induced by estrogen administration (8). The increases in serum copper and decreases in serum zinc observed during oral contraception or pregnancy are linked to this estrogen effect. The differences in manganese absorption observed between males and females result certainly from an hormonal action (9).

3. DIETARY ALLOWANCE, INTAKE, AND STATUS OF WOMEN

Trace element requirements for women vary largely with hormonal physiological changes and women’s needs are also lower than in men according to their body weight. The onset of menstruation during puberty results in increased iron losses hence iron requirements are higher in women than men until menopause. In France, daily needs are estimated at 21.4 mg of iron for menstruating teen-agers and 18.09 mg for mature women (10). During pregnancy women produce new tissues for the fetal-placental unit and these tissues are rich in trace elements, thus creating new needs for iron or zinc. Lactation induces increased needs for many trace elements that have to be present in milk to ensure adequate growth of the newborn. With the exception of iron, iodine and zinc whose recommended intake during pregnancy or lactation are increased, recommended allowances (11) do not sufficiently take known facts into account. For other trace elements, such as chromium or manganese, the recommended dietary allowances during pregnancy are unchanged thus ignoring women’s real needs.

Actual dietary intakes of women are generally far lower than recommended ones. In a large nutritional study performed in France we observed an inadequacy of intakes for zinc, iron, copper (12). Variations in the discrepancies between needs and intakes during life result in important changes in levels of trace elements in biological fluids. Thus, during the Val de Marne study in 1989, we observed a progressive decline of serum zinc with age, while copper and iron increased immediately after puberty (Figure 1). In the same population the calculation of deficit risk, i.e., the frequency of abnormally low values, shows that iron deficits become major when women menstruate or become pregnant, then disappears after the menopause. The risk of zinc deficiency increases later and becomes frequent in the elderly woman.

4. EFFECTS OF TRACE ELEMENTS SUPPLEMENTATION

4.1. During Sexual Maturation

In females, zinc deficiency triggers sexual malfunctions responsible for reproductive disorders. Abnormalities of oocytes, estrogen cycle and ovulation have been observed in