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Editorial Open Access

What are we Waiting for?

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The very demanding metabolism of pregnant and lactating females should lead to higher intakes of environmental and occupational chemicals by their respiratory tract compared to their male counterparts, during similar exposure concentrations and conditions. Additional overall energy costs in pregnant females compared to non-gravid females range from 91 614 to 99 726 kcal over the complete gestational period and correspond to extra daily costs varying from 32 to 496 kcal/day [1-3]. In late pregnancy, approximately half of the increment of 302kcal/day is required for a 3-kg fetus [4,5]. During the postpartum phase, the maternal breastfeeding requires extra daily energy costs of 106kcal/day for the metabolism of milk synthesis and from 477 to 539kcal/day for milk energy outputs [6-8]. Prior observations [9,10] indicate that energy expenditures in human are supplied by the combustion of postprandial (i.e., carbohydrates, proteins and/or fats) and/or endogen metabolic fuels (i.e. glycogen, glucose, 3-hydroxybutyric acid, acetoacetic acid and triacylglycerol) which requires about the same oxygen consumption rate (VO_2) per unit of energy expended of 0.2057 ± 0.0018 and 0.2059 ± 0.0019 L of O_2/kcal (mean ± S.D.) respectively [11]. Each additional kcal of energy expended during pregnancy and the postpartum phase compared to baseline values for non-gravid and non-lactating females requires an extra average metabolic consumption of 0.206 liter of oxygen. Consequently, in order to be adequately oxygenated pregnant and lactating females inhale more air than their non-gravid and non-lactating counter parts. This explain the progressively increase of the minute ventilation rate (VE) observed in pregnant females at rest, as early as 7 or 8 weeks of gestation. The latter value peaks up at 50% above pre-gravid levels around the second trimester, primarily due to a 40% increase in the tidal volume and a 15% increase in the respiratory frequency. This increase of the respiratory drive compensates for a loss of functional residual capacity and the fetus oxygenation of about 8 mL $O_2\,kg^{-1}min^{-1}$ [12-18,5].

Pregnant and breastfeeding females usually avoid overstrain and overwork by increasing work efficiency and adjusting daily physical activities [19-24,5-7,3]. However, VE values during exercises involving lifting the body (e.g., walking on a treadmill) are expected to by greater during pregnancy [25-30,12,13,15,16]. In normal-weight subjects, daily inhalation rates were found to be higher by 18 to 41% throughout pregnancy and 23 to 39% during postpartum weeks compared to those for males [31]. Highest 99th percentiles of 47.31m^3/day and 0.647m^3/kg-day were determined in overweight/obese pregnant women 23 to less than 30 years old at the 36th week of gestation and under-weight lactating females aged 11 to less than 23 years at the 27th postpartum week respectively. Since the ratio of the physiological dead space to the tidal volume remains unchanged, the alveolar ventilation rate (VA) is about 70% higher at the end of gestation [25,14,16,17]. Higher cardiac outputs (Q) have also been measured in pregnant females [32]. For instance, Q values were showed to increase by almost 50% and 22% from the non-pregnancy level to that at 8-11 and 29.6 weeks gestation respectively [33,34]. Higher VE, VA, Q values and others significant physiological modifications occurring during pregnancy may affect the toxicokinetics of inhaled xenobiotics [35.36]. For instance, the blood volume, renal blood flow, as well as glomerular filtration increase, whereas plasma proteins decrease. Higher tidal volume, VE and VO_2 can result in increased pulmonary distribution of toxic gas and reduce in time to reach alveolar steady state. The higher volume of distribution may prolong half-lives of many chemicals. An overall decrease in hepatic xenobiotic biotransformation during pregnancy is also observed.

It is well known that women live longer than men and have a higher percentage of body fat [37]. Lipophilic toxic chemicals absorbed into the body through air pollution are stored in fat tissue and may remain sequestered for years before being released into the general circulation [38-41]. For instance, lipophilic organochlorines stored in fats, such as dichlorodiphenyltrichloroethane and polychlorinated biphenyls are released at critical periods of life, notably during weight loss resulting from an energy-restricted diet or when hormonal change occurs during pregnancy, lactation and menopause [42-49]. Other chemicals absorbed through air pollution, such as lead, are stored in bone tissue. The mobilization of lead from bone tissue into the bloodstream has been observed during pregnancy, lactation and menopause; it also increases in calcium-deficient diets [50-71]. Lead released into the bloodstream is more pronounced in aging women than in their male counterparts [72-74,53,61,62].

Most chemicals found in the bloodstream of pregnant women may be transferred to the embryos or fetus by the umbilical cord after crossing the placenta during pregnancy, or transferred to newborns during breastfeeding in the postpartum phase [75]. In fact, numerous epidemiological studies have confirmed links between air pollutants and adverse birth outcomes in humans, such as low birth weight, premature birth and infant mortality [76-89].

Exposure to toxic chemicals during a brief duration (≈6 h) immediately following fertilization in mice has been demonstrated to result in malformed fetuses [90,91]. During the first week after the fertilization, thus before the positive pregnancy test, chemicals in sufficient exposure concentrations could alter the normal development of zygote, morula or blastocyst [35]. Perera et al. [92] have showed that prenatal exposure to carcinogens apparently results in differentially higher levels of procarcinogenic DNA damage in fetus. In certain individuals, it may disproportionately increase the probability of developing a cancer over their lifetime. Such data is relatively alarming considering that in 1982 already 42% of pregnancies were occurring in working women [93].

Overall, considering what precedes, physiological data in pregnant and lactating females should be taken into consideration for a scientifically-sound determination of indoor and outdoor hygienic standards for airborne toxic chemicals, as well as adequate non-

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hazardous safe working conditions for all females, their fetus and breastfed newborn.

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