

Proteomics and Biological Systems: Application in Oxidative Stress, Nutrition and Prenatal Development

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Editorial

In biological systems, the genomic approach has emerged to provide a better understanding of the pathophysiological conditions leading to pregnancy-associated disorders and complications, thereby providing a perspective for improving prenatal development outcomes. Nevertheless, it is insufficient to accurately predict protein expression patterns and functions from quantitative messenger RNA [mRNA] due to post-transcriptional regulation mechanisms [mRNA export, surveillance, silencing and turnover] and post-translational modifications which can determine protein activity, localization, turnover and interactions with other proteins [1]. Therefore, investigations of steady-state mRNA expression can only partially predict protein abundances in mammalian cells [2]. In fact, mRNAs are less stable than proteins [3]. In addition, mRNAs are produced at a much lower rate than proteins [4].

Since protein expression is the functional outcome of gene transcription and translation, proteomics, the global study of proteins, has emerged over the last decade to offer a unique means for analyzing the expressed genome under various physiological or pathological conditions in biological systems. Of particular interest to investigators in the field of reproductive medicine is the proteomic approach to measure the secretome, i.e. those proteins that are produced by cells and secreted in biological fluids [5]. Proteomics of biological fluids, including serum, plasma, urine and amniotic fluid, have been employed in human pregnancy research [6] to predict preterm labor and offspring outcomes [7,8] and pregnancy-associated disorders and complications [9-11]. Proteomic analysis of embryonic secretome [12] may provide early prediction markers of embryos with low or high developmental potential.

Imbalance between reactive oxygen species [ROS], by-products of normal cellular metabolism, respiration and energy production in biological systems, and ROS scavenging antioxidants induces oxidative stress that adversely affect parental development and health outcomes [13]. Two-dimensional gel electrophoresis/mass spectrometry-based proteomics approach has greatly facilitated the development of molecular medicine, importantly in the search of antioxidative and oxidative stress biomarkers in reproductive organs. For example, proteomics of the cytotrophoblast of early pregnancy [14], the placenta derived from assisted reproductive technology [15], the corpus luteum [16], and the uterine endometrium [17,18] obtained during the peri-implantation period of pregnancy have been used to identify oxidative stress biomarkers and functional redox-sensitive proteins crucial for endometrium receptivity, embryonic implantation and development.

Maternal peri-conception dietary intake and composition are important environmental factors influencing maternal health, and pre and post-natal development outcomes. Proteomics is expected to have

an impact in solving malnutrition-associated disorders and pathologies, such as intrauterine fetal growth restriction [19] in association with oxidative stress. In ongoing research focused on the adverse effect of environmental factors-induced oxidative stress on prenatal developmental outcomes, it is important to highlight the role that proteomics can play in identifying protein expression levels and protein modifications mediated by oxidative stress [20]. Proteomics may also provide new insights into antioxidant adaptations mediated in biological systems in response to oxidative stress induced by maternal malnutrition [21], following exposure to various environmental pollutants and/or unhealthy lifestyle behaviors during the peri-conception period [22,23].

Maternal malnutrition and/or exposure to environmental pollutants adversely affect fetal development and subsequent child health outcome. Several of the major diseases of later life find their origins during early prenatal developmental processes in association with oxidative stress induced by environmental factors, mainly peri-conceptional malnutrition [24] and exposure to a mixture of environmental pollutants and lifestyle behaviors [22]. Many dietary compounds of plant origin with well known significant activity as antioxidants against ROS-induced oxidative damage in biological systems have potential implication in health care and prevention of disease [25]. Therefore, it is necessary to implement potential preventive nutritional antioxidant therapies for populations at high risk for adverse pregnancy outcome. The search for biomarkers of oxidative stress by proteomics in biological fluids could assist in the development and application of nutritional antioxidant therapies against environmental factors-induced oxidative stress and adverse prenatal development and health outcomes.

In the context of the climate changes and the negative impact of global population growth on the environment and natural resources, a large part of the world population will be confronted with maintaining proper nutrition. Maternal food insecurity [26] during the peri-conception period [27] will be the major challenge to face. International cooperation and joints research projects between public research institutions and private firms, mainly those engaged in agricultural development and food security will be therefore necessary to develop specific tools of prenatal screening and applied nutritional therapies. Therapeutic nutritional strategies must take in consideration women's socioeconomic status. Funding for future research in the field of nutrition, environmental pollution and health should be directed into the epidemiological and preventive studies instead of experiments on animals.

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