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# The Maternal Thyroid Gland as A Sentinel Organ for A Development: Signs of The Possible Harm of Air Pollution in Development

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## COMMENTARY

The systematic modifications in the maternal thyroid hormones (THs) levels during pregnancy are needed to get a regular fetal and neonatal development (El-bakry et al., 2010; Ahmed, 2011, 2013, 2015, 2016a-c, 2017a-c & 2018a-c; Ahmed et al., 2008; 2010, 2012; 2015 a, b & 2018 a, b; Ahmed and Incerpi, 2013; Van Herck et al., 2013; Incerpi et al., 2014; Candelotti et al., 2015; De Vito et al., 2015; El-Ghareeb et al., 2016; Ahmed and El-Gareib, 2017). Air pollution includes a complicated mixture of liquids, gases, and particulate matter (PM10, 2.5 or 0.1 mm) (Brook et al., 2004; Pope and Dockery, 2006; Sun et al., 2010). The other pollutants involve polycyclic aromatic hydrocarbons (PAHs), ground-level ozone ($O_3$), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), nitric oxide (NO), and carbon monoxide (CO) (Zheng et al., 2016). In addition, the major sources of air pollutants are indoor cooking, motor vehicle emissions, construction and demolition actions, industrial combustions, and power plants (Lee et al., 2014). Tobacco smoking is an extra appropriate source of exposure to heavy metals includes lead (Pb) and cadmium (Cd) (Mussalo- Rauhamaa et al., 1986; Marano et al., 2012). Inhalation of the polluted air is the chief pathway of exposure (Pronczuk- Garbino, 2007). Thus, all humans are exposed to these pollutions in particular in low- and middle-income countries (Zheng et al., 2016).

There has been cumulative concern about the harmful health consequences of air pollutants. The exposure to airborne PAHs (Baccarelli et al. 2008; Abdelouahab et al. 2013), active or passive cigarette smoke (Soldin et al. 2009) and cadmium (Iijima et al. 2007) might alter the levels of 3,5,3'-triiodothyronine (T3) and thyroxine (T4) in neonates and adults. Exposure to ambient PM2.5 pollution during the gestation can increase the risk of adverse gestational outcome (Pedersen et al. 2013) including the preterm birth (Rappazzo et al. 2014) and low birth weight (Pedersen et al. 2013). More importantly, several authors (Medici et al., 2013; Korevaar et al., 2016; Janssen et al., 2017) reported that exposure women to airborne PM2.5 during pregnancy can disrupt the activities of free T4, free T3 and thyroid-stimulating-hormone (TSH) and contribute to decrease the birth weight. Moreover, PM exposure in rats can perturb the action of hypothalamic–pituitary– thyroid axis (HPTA) (Thomson et al. 2013). Exposure pregnant to urbane air might induce premature deaths (Cohen et al., 2017). These variations may be attributed to PM exposure during the gestation can increase the activity of glucocorticoid (Thomson et al. 2013) suppressing the release of TSH (Wilber and Utiger 1969). Also, the anti-inflammatory actions of glucocorticoids can induce the response of a systemic oxidative stress (Janssen et al. 2012) and elevate the placental protein-bound 3-nitrotyrosine (Saenen et al. 2016). Alternatively, PM2.5 can enter the lungs and blood circulation, where they may prompt the release of oxidative stress resulting in several neurodevelopment complications (Grahame et al., 2014). Furthermore, the disturbance in the activity of THs during pregnancy can cause several attention deficit and hyperactivity disorder (ADHD) in neonates (Modesto et al. 2015). Costa et al. (2017) and

Ye et al. (2017) observed that exposure pregnant to air pollutants during the late pregnancy or early postnatal period can increase the possibility of autism spectrum disorders and cognitive deficits in children. In general, exposure to air pollutants can cause several neurological diseases such as schizophrenia (Pedersen et al., 2004), depression (Lim et al., 2012), and dementia (Power et al., 2016; Tzivian et al., 2016; Chen et al., 2017). Moreover, exposure to air pollution can cause mortality and morbidity from cardiovascular and respiratory diseases (Pope et al., 2002 & 2007; Pelucchi et al., 2009; Newby et al., 2015).

Finally, the current short commentary proposed that air pollutants may act as developmental endocrine disruptors perturbing the actions of HPTA and may delay the development and growth. This disturbance during gestation may increase the fetal and neonatal complications including teratogenic outcomes, preterm birth, and several brain disorders. Additional investigation is required to assess possible outcomes later in life.

## CONFLICT OF INTEREST

The author declares that no competing financial interests exist.

## REFERENCES


[1] Abdelouahab, N., Langlois, M.F., Lavoie, L., Corbin, F., Pasquier, J.C., Takser, L., 2013. Maternal and cord- blood thyroid hormone levels and exposure to polybrominated diphenyl ethers and polychlorinated biphenyls during early pregnancy. Am J Epidemiol 178(5), 701–713.

[2] Ahmed, O.M., Abd El-Tawab, S.M., Ahmed, R.G., 2010. Effects of experimentally induced maternal hypothyroidism and hyperthyroidism on the development of rat offspring: I- The development of the thyroid hormones-neurotransmitters and adenosinergic system interactions. Int. J. Dev. Neurosci. 28, 437-454.

[3] Ahmed, O.M., Ahmed, R.G., El-Gareib, A.W., El-Bakry, A.M., Abd El-Tawab, S.M., 2012. Effects of experimentally induced maternal hypothyroidism and hyperthyroidism on the development of rat offspring: II-The developmental pattern of neurons in relation to oxidative stress and antioxidant defense system. Int. J. Dev. Neurosci. 30, 517–537.

[4] Ahmed, O.M., El-Gareib, A.W., El-bakry, A.M., Abd El-Tawab, S.M., Ahmed, R.G., 2008. Thyroid hormones states and brain development interactions. Int. J. Dev. Neurosci. 26(2), 147-209. Review.

[5] Ahmed, R.G., 2011. Perinatal 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin exposure alters developmental neuroendocrine system. Food Chem. Toxicology, 49, 1276–1284.

[6] Ahmed, R.G., 2013. Early weaning PCB 95 exposure alters the neonatal endocrine system: thyroid adipokine dysfunction. J. Endocrinol. 219 (3), 205-215.

[7] Ahmed, R.G., 2015. Hypothyroidism and brain developmental players. Thyroid Research J. 8(2), 1-12.

[8] Ahmed, R.G., 2016a. Gestational dexamethas one alters fetal neuroendocrine axis. Toxicology Letters, 258, 46–54.

[9] Ahmed, R.G., 2016b. Maternal iodine deficiency and brain disorders. Endocrinol. Metab. Syndr. 5, 223. http://dx.doi.org/ 10.4172/2161-1017.1000223.

[10] Ahmed, R.G., 2016c. Maternal bisphenol A alters fetal endocrine system: Thyroid adipokine dysfunction. Food Chem. Toxicology, 95, 168-174.

[11] Ahmed, R.G., 2017a. Hyperthyroidism and developmental dysfunction. Arch Med. 9, 4.

[12] Ahmed, R.G., 2017b. Perinatal hypothyroidism and cytoskeleton dysfunction. Endocrinol Metab Syndr 6, 271. doi:10.4172/2161-1017. 1000271

[13] Ahmed, R.G., 2017c. Developmental thyroid diseases and monoaminergic dysfunction. Advances in Applied Science Research 8(3), 01-10.

[14] Ahmed, R.G., 2018a. Maternal hypothyroidism and neonatal depression: Current perspective. International Journal of Research Studies in Zoology 4(1), 6-10. DOI: http://dx.doi.org/ 10.20431/2454-941X.0401002.

[15] Ahmed, R.G., 2018b. Non-genomic actions of thyroid hormones during development. App Clin Pharmacol Toxicol: ACPT-108. DOI: 10.29011/ACPT-109. 100008.

[16] Ahmed, R.G., 2018c. Interactions between thyroid and growth factors during development. ARC Journal of Diabetes and Endocrinology 4(1), 1-4. DOI: http://dx.doi.org/10.20431/2455-5983.0401001.

[17] Ahmed, R.G., Abdel-Latif, M., Ahmed F., 2015a. Protective effects of GM-CSF in experimental neonatal hypothyroidism. International Immunopharmacology 29, 538–543.

[18] Ahmed, R.G., Abdel-Latif, M., Mahdi, E., El-Nesr, K., 2015b. Immune stimulation improves endocrine and neural fetal outcomes in a model of maternofetal thyrotoxicosis. Int. Immunopharmacol. 29, 714-721.

[19] Ahmed, R.G., El-Gareib, A.W., 2017. Maternal carbamazepine alters fetal neuroendocrine-cytokines axis. Toxicology 382, 59–66.

[20] Ahmed, R.G., El-Gareib, A.W., Shaker, H.M., 2018a. Gestational 3,3′,4,4′,5-pentachlorobiphenyl (PCB 126) exposure disrupts fetoplacental unit: Fetal thyroid-cytokines dysfunction. Life Sciences 192, 213–220.

[21] Ahmed, R.G., Incerpi, S., 2013. Gestational doxorubicin alters fetal thyroid–brain axis. Int. J. Devl. Neuroscience 31, 96–104.

[22] Ahmed, R.G., Walaa G.H., Asmaa F.S., 2018b. Suppressive effects of neonatal bisphenol A on the neuroendocrine system. Toxicology and Industrial Health Journal (in press).

[23] Baccarelli, A., Giacomini, S.M., Corbetta, C., Landi, M.T., Bonzini, M., Consonni, D., 2008. Neonatal thyroid function in Seveso 25 years after maternal exposure to dioxin. PLoS Med 5(7), e161, doi: 10.1371/journal.pmed.0050161.

[24] Brook, R.D., Franklin, B., Cascio, W., 2004. Air pollution and cardiovascular disease: a statement for healthcare professionals from the expert panel on population and prevention science of the American Heart Association. Circulation 109, 2655-71.

[25] Candelotti, E., De Vito, P., Ahmed, R.G., Luly, P., Davis, P.J., Pedersen, J.Z., Lin, H-Y., Incerpi, I., 2015. Thyroid hormones crosstalk with growth factors: Old facts and new hypotheses. Immun., Endoc. & Metab. Agents in Med. Chem., 15, 71-85.

[26] Chen, H., Kwong, J.C., Copes, R., Tu, K., Villeneuve, P.J., van Donkelaar, A., Hystad, P., Martin, R.V., Murray, B.J., Jessiman, B., Wilton, A.S., Kopp, A., Burnett, R.T., 2017. Living near major roads and the incidence of dementia, Parkinson's disease, and multiple sclerosis: a population based cohort study. Lancet 389, 718-726.

[27] Cohen, A.J., Brauer, M., Burnett, R., Anderson, H.R., Frostad, J., Estep, K., Balakri shnan, K., Brunekreef, B., Dandona, L., Dandona, R., Feigin, V., Freedman, G., Hubbell, B., Jobling, A., Kan, H., Knibbs, L., Liu, Y., Martin, R., Morawska, L., Pope, C.A., 3rd, Shin, H., Straif, K., Shaddick, G., Thomas, M., van Dingenen, R., van Donkelaar, A., Vos, T., Murray, C.J.L., Forouzanfar, M.H., 2017. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. Lancet 389, 1907-1918.

[28] De Vito, P., Candelotti, E., Ahmed, R.G., Luly, P., Davis, P.J., Incerpi, S., Pedersen, J.Z., 2015. Role of thyroid hormones in insulin resistance and diabetes. Immun., Endoc. & Metab. Agents in Med. Chem., 15, 86-93.

[29] El-bakry, A.M., El-Ghareeb, A.W., Ahmed, R.G., 2010. Comparative study of the effects of experimentally-induced hypothyroidism and hyperthyroidism in some brain regions in albino rats. Int. J. Dev. Neurosci. 28, 371-389.

[30] El-Ghareeb, A.A., El-Bakry, A.M., Ahmed, R.G., Gaber, A., 2016. Effects of zinc supplementation in neonatal hypothyroidism and cerebellar distortion induced by maternal carbimazole. Asian Journal of Applied Sciences 4(04), 1030-1040.

[31] Grahame, T.J., Klemm, R., Schlesinger, R.B., 2014. Public health and components of particulate matter: the changing assessment of black carbon. J. Air & Waste Manag. Assoc. 64, 620-660.

[32] Iijima, K., Otake, T., Yoshinaga, J., Ikegami, M., Suzuki, E., Naruse, H., 2007. Cadmium, lead, and selenium in cord blood and thyroid hormone status of newborns. Biol Trace Elem Res 119(1), 10–18.

[33] Incerpi, S., Hsieh, M-T., Lin, H-Y., Cheng, G-Y., De Vito, P., Fiore, A.M., Ahmed, R.G., Salvia, R., Candelotti, E., Leone, S., Luly, P., Pedersen, J.Z., Davis, F.B., Davis, P.J., 2014. Thyroid hormone inhibition in L6 myoblasts of IGF-I-mediated glucose uptake and proliferation: new roles for integrin αvβ3. Am. J. Physiol. Cell Physiol. 307, C150–C161.

[34] Janssen, B.G., Munters, E., Pieters, N., Smeets, K., Cox, B., Cuypers, A., 2012. Placental mitochon-drial DNA content and particulate air pollution during in utero life. Environ Health Perspect 120, 1346–1352, doi: 10.1289/ ehp.1104458.

[35] Janssen, B.G., Saenen, N.D., Roels, H.A., Madhloum, N., Gyselaers, W., Lefebvre, W., Penders, J., Vanpoucke, C., Vrijens, K., Nawrot, T.S., 2017. Fetal thyroid function, birth weight, and in utero exposure to fine particle air pollution: a birth cohort study. Environ Health Perspect 125, 699–705. http://dx.doi.org/10.1289/EHP508.

[36] Korevaar, T.I., Chaker, L., Jaddoe, V.W., Visser, T.J., Medici, M., Peeters, R.P., 2016. Maternal and birth characteristics are determinants of offspring thyroid function. J Clin Endocrinol Metab 101(1), 206–213.

[37] Lee, B-J., Kim, B., Lee, K., 2014. Air pollution exposure and cardiovascular disease. Toxicol Res 30, 71.

[38] Lim, Y.H., Kim, H., Kim, J.H., Bae, S., Park, H.Y., Hong, Y.C., 2012. Air pollution and symptoms of depression in elderly adults. Environ Health Perspect 120, 1023-1028.

[39] Marano, K.M., Naufal, Z.S., Kathman, S.J., 2012. Cadmium exposure and tobacco consumption: biomarkers and risk assessment. Regul Toxicol Pharmacol 64, 243-52.

[40] Medici, M., Timmermans, S., Visser, W., de Muinck Keizer-Schrama, S.M., Jaddoe, V.W., Hofman, A., 2013. Maternal thyroid hormone parameters during early pregnancy and birth weight: the Generation R Study. J Clin Endocrinol Metab 98(1), 59–66.

[41] Modesto, T., Tiemeier, H., Peeters, R.P., Jaddoe, V.W., Hofman, A., Verhulst, F.C., 2015. Maternal mild thyroid hormone insufficiency in early pregnancy and attention-deficit/hyperactivity disorder symptoms in children. JAMA Pediatr 169(9), 838–845.

[42] Mussalo-Rauhamaa, H., Salmela, S., Leppänen, A., Pyysalo, H., 1986. Cigarettes as a source of some trace and heavy metals and pesticides in man. Arch Environ Health 41, 49-55.

[43] Newby, D.E., Mannucci, P.M., Tell, G.S., Baccarelli, A.A., Brook, R.D., Donaldson, K., Forastiere, F., Franchini, M., Franco, O.H., Graham, I., Hoek, G., Hoffmann, B., Hoylaerts, M.F., Kunzli, N., Mills, N., Pekkanen, J., Peters, A., Piepoli, M.F., Rajagopalan, S., Storey, R.F., Esc Working Group on Thrombosis, E.A.f.C.P., Rehabilitation, Association, E.S.C.H.F., 2015. Expert position paper on air pollution and cardiovascular disease. Eur Heart J 36, 83-93.

[44] Pedersen, C.B., Raaschou-Nielsen, O., Hertel, O., Mortensen, P.B., 2004. Air pollution from traffic and schizophrenia risk. Schizophrenia Research 66, 83-85.

[45] Pedersen, M., Giorgis-Allemand, L., Bernard, C., Aguilera, I., Andersen, A.M.N., Ballester, F., 2013. Ambient air pollution and low birthweight: a European cohort study (ESCAPE). Lancet Res Med 1(9), 695–704.

[46] Pelucchi, C., Negri, E., Gallus, S., Boffetta, P., Tramacere, I., La Vecchia, C., 2009. Long-term particulate matter exposure and mortality: a review of European epidemiological studies. BMC Public Health 9, 453.

[47] Pope C.A., 2007. Mortality effects of longer term exposures to fine particulate air pollution: review of recent epidemiological evidence. Inhal. Toxicol. 19 (Suppl. 1), 33–38.

[48] Pope, C.A., Burnett, R.T., Thun, M.J., Calle, E.E., Krewski, D., Ito, K., Thurston, G.D., 2002. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA 287, 1132–1141.

[49] Pope, C.A., Dockery, D.W., 2006. Health effects of fine particulate air pollution: lines that connect. J Air Waste Manag Assoc 56, 709-42.

[50] Power, M.C., Adar, S.D., Yanosky, J.D., Weuve, J., 2016. Exposure to air pollution as a potential contributor to cognitive function, cognitive decline, brain imaging, and dementia: A systematic review of epidemiologic research. Neurotoxicology 56, 235-253.

[51] Pronczuk-Garbino, J., 2007. Children's health and the environment. A global perspective. Int J Public Health 52, 67-8.

[52] Rappazzo, K.M., Daniels, J.L., Messer, L.C., Poole, C., Lobdell, D.T., 2014. Exposure to fine particulate matter during pregnancy and risk of preterm birth among women in New Jersey, Ohio, and Pennsylvania, 2000–2005. Environ Health Perspect 122, 992–997, doi: 10.1289/ehp.1307456.

[53] Saenen, N.D., Vrijens, K., Janssen, B.G., Madhloum, N., Peusens, M., Gyselaers, W., 2016. Placental nitosative stress and exposure to ambient air pollution during gestation: a population study. Am J Epidemiol 184(6), 442–449.

[54] Soldin, O.P., Goughenour, B.E., Gilbert, S.Z., Landy, H.J., Soldin, S.J., 2009. Thyroid hormone levels associated with active and passive cigarette smoking. Thyroid 19(8), 817–823.

[55] Sun, Q., Hong, X., Wold, L.E., 2010. Cardiovascular effects of ambient particulate air pollution exposure. Circulation 121, 2755-65.

[56] Thomson, E.M., Vladisavljevic, D., Mohottalage, S., Kumarathasan, P., Vincent, R., 2013. Mapping acute systemic effects of inhaled particulate matter and ozone: multiorgan gene expression and gluco-corticoid activity. Toxicol Sci 135(1), 169–181.

[57] Tzivian, L., Dlugaj, M., Winkler, A., Weinmayr, G., Hennig, F., Fuks, K.B., Vossoughi, M., Schikowski, T., Weimar, C., Erbel, R., Jockel, K.H., Moebus, S., Hoffmann, B., Heinz Nixdorf Recall study Investigative, G., 2016. Long-Term Air Pollution and Traffic Noise Exposures and Mild Cognitive Impairment in Older Adults: A Cross-Sectional

Analysis of the Heinz Nixdorf Recall Study. Environ Health Perspect 124, 1361-1368.

[58] Van Herck, S.L.J., Geysens, S., Bald, E., Chwatko, G., Delezie, E., Dianati, E., Ahmed, R.G., Darras, V.M., 2013. Maternal transfer of methimazole and effects on thyroid hormone availability in embryonic tissues. Endocrinol. 218, 105-115.

[59] Wilber, J.F., Utiger, R.D., 1969. The effect of gluco-corticoids on thyrotropin secretion. J Clin Invest 48(11), 2096–2103.

[60] Ye, B.S., Leung, A.O.W., Wong, M.H., 2017. The association of environmental toxicants and autism spectrum disorders in children. Environmental Pollution 227, 234-242.

[61] Zheng, T., Zhang, J., Sommer, K., Bassig, B.A., Zhang, X., Braun, J., Xu, S., Boyle, P., Zhang, B., Shi, K., Buka, S., Liu, S., Li, Y., Qian, Z., Dai, M., Romano, M., Zou, A., Kelsey, K., 2016. Effects of environmental exposures on fetal and childhood growth trajectories. Annals of Global Health, 82(1), 41-99.

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