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MERCURY EXPOSURE AND HUMAN REPRODUCTIVE HEALTH (LITERATURE REVIEW)

СЫМАПТЫН АДАМДЫН РЕПРОДУКТИВДИК ДЕН-СООЛУГУНА ТААСИРИ (АДАБИЙ СЕРЕП)

ВОЗДЕЙСТВИЕ РТУТИ И РЕПРОДУКТИВНОЕ ЗДОРОВЬЕ ЧЕЛОВЕКА (ЛИТЕРАТУРНЫЙ ОБЗОР)

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MERCURY EXPOSURE AND HUMAN REPRODUCTIVE HEALTH (LITERATURE REVIEW)

Abstract

Mercury (Hg), a highly toxic environmental pollutant, which hazards for human health, including to reproductive system, fertility and pregnancy outcome. Research has shown that Hg could induce impairments in the reproductive function due to cellular deformation of the Leydig cells and the seminiferous tubules, testicular degeneration and degenerative atresia of primordial and primary follicles as well as diminishes the steroidogenesis and synthesis of sex hormones. Some studies investigated miscarriage, spontaneous abortions, stillbirth, and low birth weight due to occupational Hg exposure. This review evaluates the hypothesis that exposure to Hg may. This review evaluates the hypothesis that chronic exposure to mercury can increase the risk of reduced fertility, spontaneous abortion and congenital deficits or abnormalities.

Keywords: Mercury, exposure, male fertility, female fertility, fetotoxicity.

СЫМАПТЫН АДАМДЫН РЕПРОДУКТИВДИК ДЕН-СООЛУГУНА ТААСИРИ (АДАБИЙ СЕРЕП)

Аннотация

Сымап (Hg) өтө уулуу айлана-чөйрөнү булгаган зыяндуу зат, адамдын ден-соолугуна, айрыкча репродуктивдик системага, тукумдуулукка жана кош бойлуулуктун натыйжасына коркунуч туудурат. Изилдөөлөр көрсөткөндөй, сымап репродуктивдик функциясынын начарлашына, стероидогенезди жана жыныстык гормондордун синтезин бузат. Лейдиг клеткаларынын, уруктук түтүктөрдүн жана примордиалдык, өсүп жаткан фолликулдардын дегенерациялык атрезиясына жана клеткалык деформациясына алып келиши мүмкүн. Айрым изилдөөлөрдө өзүнөн өзү бойдон түшуу, өспөй калуусу жана өлүү төрөт жана салмагы төмөн бала төрөлушүнө сымаптын кесиптик таасиринен улам тукум улоонун татаалдашуусу изилденген. Бул кароодо сымаптын өнөкөт таасири тукумдуулуктун төмөндөшүнө, кош бойлуулукка терс таасири жана ымыркайдын тубаса кемтиктерине же аномалияларга дуушар болуу коркунучун жогорулатат деген гипотеза бааланат.

Ачкыч сөздөр: сымап, экспозиция, аялдардын тукумдуулугу, эркектердин тукумдуулугу, фетотоксикация.

ВОЗДЕЙСТВИЕ РТУТИ И РЕПРОДУКТИВНОЕ ЗДОРОВЬЕ ЧЕЛОВЕКА (ЛИТЕРАТУРНЫЙ ОБЗОР)

Аннотация

Ртуть (Hg)- высокотоксичное вредное вещество, загрязняющее окружающую среду, которое представляет опасность для здоровья человека, особенно репродуктивной системы, фертильности и исходов беременности. Исследования показали, что ртуть способствует нарушению репродуктивной функции, нарушению стероидогенеза и синтеза половых гормонов. Это может привести к дегенеративной атрезии и клеточной деформации клеток Лейдига, семенных протоков и примордиальных и растущих фолликулов. В некоторых исследованиях изучались осложнения беременности, самопроизвольные выкидыши, задержку роста и мертворождение, а также рождение ребенка с низкой массой тела при рождении из-за профессионального воздействия ртути. В этом обзоре оценивается гипотеза о том, что хроническое воздействие ртути может привести к снижению фертильности, негативному влиянию на беременность и повышенному риску врожденных дефектов или аномалий плода.

Ключевые слова: Ртуть, воздействие, мужская фертильность, женская фертильность, фетотоксичность.

Introduction

Infertility is defined, by the World Health Organization (WHO), as a disease of the reproductive system that consists in the failure to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse (Jenardhanan, 2016, pp.126-140). It is estimated that nearly 15% of couples are infertile and in approximately 50% the causes are unknown. Lifestyle factors related with smoking, alcohol or caffeine intake and environmental risk factors, namely exposure to heavy metals such as mercury (Hg), lead, cadmium and/or mixture of metals may impact the reproductive system (Al-Saleh, 2011, pp. 560-579; Takahashi, 2003, p. 23-33; Han, 2018, p. 543-553).

Hg is a naturally-occurring chemical element found on Earth, existing in three different forms. (Dickman, 1998, p. 165-174). In humans, Hg exposure occurs predominantly through the consumption of seafood or sashimi, but also dental amalgams, button cell batteries, broken thermometers and compact fluorescent light bulbs and skin-lightening creams. (Choy, 2002, p. 426-428; Arakawa, 2006, p. 337-344).

Hg causes adverse effects on male reproductive functions in rats, namely impairment of spermatogenesis, decrease in sperm motility and increase in the number of sperm head abnormalities (Cole, 2006, p. 13-19; Al-Saleh, 2008, p. 560-579; Meeker, 2010, p.130-140). In females, data indicate that Hg exposure can result in an accumulation in ovaries of mice that may cause alterations in reproductive behavior and contribute to infertility or ovarian failure (Bloom, 2010, p. 298-305). Moreover, there is transplacental passage of Hg in animals (Bloom, 2011, p. 164-170). However, despite numerous animal studies, whether Hg affects human reproductive health remains unclear.

To our knowledge, no systematic review and/or meta-analysis reported the effect of Hg on human fertility and generally on human reproductive health. Given the Hg exposure in the general population, understanding the impact of Hg on human fertility is relevant for public health policies. Therefore, we systematically reviewed the available literature to evaluate the influence of Hg exposure on human fertility and/or adverse reproductive outcomes.

Methods

A systematic review of available literature was carried out by searching within a number of databases, including PubMed, Google, Medline, Scopus and Google scholar. These searches were conducted using a number of keywords or key terms, including which were: “mercury exposure and health”, ‘characteristics of mercury”, “sources of mercury”, “environmental mercury exposure”, “male human reporoduction”, “female human reproduction”, “pregnancy”, “dental amalgam' mercury exposure”, “fish intake related mercury exposure”, “fetotoxicity”, “reproductive toxic potential”, “erectile dysfunction”, “libido”, “semen quality”, “menstruation cycle”, and “fertility”. A further search was conducted into mercury exposure through dental amalgam and human reproductive health, consumption of fish/seafood with regards to mercury and reproduction, pregnancy or its outcome. More than two hundred twenty-five articles were identified, and seventy-five relevant articles were incorporated in this review.

The article is divided into three sections: general overview of mercury (uses of Hg, physical and chemica characteristics and sources of mercury), impact of mercury on reproductive system: male reproduction and female reproduction and effects of mercury on pregnancy or its outcome. The data from the three sections is summarized in Tables 1-5 for better and quick appraisal.

Results and Discussion

The relative number or percentages of publications in the 10 different areas of Hg research may reflect the recent research focus. It is not surprising that the highest number of papers was on environmental monitoring and exposure assessment. This is the first step of hazard identification in many regions around the world. There was almost an equal number of studies reporting effects of Hg on maternal-child health and adult fish consuming populations. There were some of papers reporting results on the interactions between nutrients and Hg effects. The risk of Hg exposure on artisanal and small-scale gold miners and effects of dental amalgam have been intensive areas of research. The potential risk of Thimerosal-containing vaccines remains to be a concern and studied. Genetic polymorphisms have been identified to be important modifiers or confounding factors affecting the toxicokinetics and effects of Hg. The following sections will discuss the state of the knowledge and knowledge gaps in each of these areas (Ha, E., 2017, pp. 419-433). Both acute and chronic mercury exposure can cause deleterious effects on human health during early life growth and development and there is no known safe dose of mercury exposure reported for human beings. Furthermore, prenatal, and postnatal mercury exposure may occur by different pathways, although bio-accumulation is reported to mostly occur through the aquatic food chain (Bose-O'Reilly S et.al., 2010, pp. 186-21). As has been noted, mercury exposure negatively impacts on human reproductive health, by altering the reproductive as well as the endocrine systems of both sexes. However, the molecular mechanisms behind mercury-linked decline in fertility potential are unclear (Henriques MC et.al.,2019, pp. 93-103).

Uses of Mercury

Mercury is an extremely rare element in the Earth's crust. It occurs in deposits throughout the world mostly as cinnabar (Mercuric Sulfide). In 2007, China was the top producer of mercury with almost two-thirds global share followed by Kyrgyzstan. Mercury as a metal is used for extraction of gold and silver, as a catalyst for chlor-alkali production, in manometers for measuring and controlling pressure, in thermometers, in electrical and electronic switches, in fluorescent lamps, and in dental amalgam fillings. Chemical compounds of mercury have found uses in batteries, in biocides in paper industry, in paints, and on seed grain, as antiseptics in pharmaceuticals, as reagents in laboratories, and as catalysts. (Brown, 2009, p. 25-30)

Physical Characteristics of Mercury

Mercury is a heavy, silvery-white metal that is liquid at room temperature. Compared to other metals, it is a poor conductor of heat, but a fair conductor of electricity (Hammond, 2006, p. 97) [Table 1]

Table 1. Physical characteristics of mercury

Freezing point	-38.83 °C [Norrby,L. 1991, p.110][Senese,F. 2007][Lide,d.r.,ed. 2005. pp. 4.125–4.126.]
Boiling point	356.73 °C [Norrby,L. 1991, p.110][Senese,f. 2007][Lide,d.r.,ed. 2005, pp. 4.125–4.126.]]

Density	13.5 g/ml
Melting point	234.3210 K (−38.8290 °C, −37.8922 °F)
Heat of vaporization	59.11 kJ/mol
Molar heat capacity	27.983 J/(mol·K) C [Norrby,l.j. 1991, p.110]

Chemical Characteristics of Mercury

Mercury does not react with most acids, such as dilute sulfuric acid, although oxidizing acids such as concentrated sulfuric acid and nitric acid or aqua regia dissolve it to give sulfate, nitrate, and chloride. Like silver, mercury reacts with atmospheric hydrogen sulfide. Mercury reacts with solid sulfur flakes, which are used in mercury spill kits to absorb mercury (spill kits also use activated carbon and powdered zinc).

Source of Mercury

Mercury in the environment is constantly cycled and recycled through a biogeochemical cycle. The cycle has six major steps. Degassing of mercury from rock, soils, and surface waters, or emissions from volcanoes and from human activities.

- Movement in gaseous form through the atmosphere.
- Deposition of mercury on land and surface waters.
- Conversion of the element into insoluble mercury sulfide.
- Precipitation or bioconversion into more volatile or soluble forms such as methylmercury.
- Reentry into the atmosphere or bioaccumulation in food chains (Schrag, 1985, p. 567-592).

Natural sources

Natural levels of mercury exist in soil, air, and water around the world. The most common geological deposits of mercury are cinnabar, a mercury sulfide mineral that can be composed of up to 86% mercury. Mercury is naturally present in raw materials such as coal, crude oil and other fossil fuels. It is also present in some minerals such as limestone, and in some metal ores that contain other metals such as zinc, copper and gold. Various natural processes, including volcanic eruptions, weathering of rocks, and undersea vents can release mercury from the Earth's crust into water bodies, soils, and the atmosphere. Natural sources account for roughly 60% of the mercury deposited in Canada each year. Mercury travels around the planet in complex ways over decades. In its elemental form (its pure form), mercury evaporates easily and can enter the mercury cycle or be transported long distances by global wind currents. As mercury enters the environment, it can be stored in vegetation, water bodies and soils. Mercury can be released to the environment through the decomposition of vegetation, forest fires, and emission from water bodies, particles in air from sea salt spray, and leaching from soils into water. In addition, mercury deposited from natural and human-made sources can be re-emitted by natural processes and then end up in the atmosphere again. Scientists are still working to determine what impact climate change will have on the global movement and cycling of mercury (Schrag, 1985, p. 567-592).

Mercury Contents in the Environment

Mercury contents in the air

In order to give insightful evidence about Hg toxicology in human beings, firstly, we would like to address its pollution dynamics. An indicator of air pollution control in most countries is used when defining the emission limit of the pollutant. Coal mining and cinnabar mining are the main sources of Hg air pollution, particularly in China. Airborne Hg passes a complex transformation cycle and acts as a global pollutant. Measurement of Hg content in the air of some industrial regions of China showed an increase in its levels in the range of 99.0-611 μg/m3. (Morck et al, 2015, p. 96-105). During the period from 2025 to 2030, the Hg emission limit should be reduced to 1 μg/m3. To achieve this, alternative energy technologies, as well as measures on Hg elimination from the environment, must be developed and implemented. (Wu, 2018, p. 218-225). Study of relevance between exposure of pregnant women to industrial air pollution with Hg in the United States and low birthweight in the offspring showed significantly positive odds ratios (OR 1.04, 95% CI 1.02, 1.07). (Zhu, 2018, p. 718-727; Deng, 2019, p. 281-289). In urbanized places where it is employed kerosene for cooking, aerial emission of pollutants, including heavy metals such as Hg, may affect household microenvironments, where women and children live daily. Women using kerosene showed enhanced cord blood levels of Hg and further heavy metals, besides to reduced vitamins such as B6 and folates ($P < 0.05$), and moreover, they were associated with a reduced newborn weight at the birth, an evidence reported after the correct adjustment of potential confounders ($\beta \pm$ standard error (SE) $= -0.326 \pm 0.155$; $P = 0.040$). (Deng, 2019, p. 281-289).

Mercury levels in the soil

The release of Hg from sources into the atmosphere can spread over long distances. Most of the environmental Hg, particularly in its ionic bivalent form, is localized at the site of matrix deposition and causes local environmental pollution. (Wu, 2018, p. 218-225) To regulate the content of Hg in the soil, it is necessary to study its accumulation, distribution and sources. Soils of Chinese industrial regions have Hg content ranging from 310 to 3760 μg/kg. (Zhu, 2018, p.718-727; Deng, 2019, p. 281-289; Tanner, 2018, p. 830-838) Mercury concentration in rice ranged from 10 to 40 μg/kg, and 43% of the samples exceeded the regulatory limit value (20 mg/kg).(Deng, 2019, p. 281-289). In anaerobic soils, there are conditions for the production of Hg which accumulates in rice and enters the human body through food chains. A significant increase of Hg concentration is found in drainage waters compared to irrigation waters in the ploughing season, which indicates the need to reduce the Hg concentration during this period (Quintana, 2018, p.839-842). Mercury contamination of soils is a great concern because of the Hg diffusion in groundwaters. (Rodenhouse et al. 2019, p.1125-1134). The possibility of contaminating soil-related components with heavy metals and Hg is, therefore, very frequently associated with the risk of Hg intake via raw food. (Rodenhouse et al 2019, p.1125-1134; Castano et al. 2015, p.58-68).

Mercury levels in blood and urine

Bio monitoring of the state of maternal and child health conducted in the framework of the COPHES/ DEMOCOPHES project reported that the Hg concentration in the urine of mothers living in the city was higher than in rural women. (Morck et al. 2015, p. 96-105). Hg concentration in the mother’s hair was higher than in children. Its level increased in accordance with the number of dental amalgam fillings in the children, as well as the consumption of marine and fish products. (Forysova et al., 2017, p. 421-430).

Impact of Mercury in Reproductive System

Literature review revealed a number of negative impacts of mercury on human reproduction. These included effects on semen quality, including reduced sperm count, motility, and changes in morphology that may reduce fertility potential. There may also be an effect in changing reproductive hormone levels.

Mercury can precipitate pathophysiological changes along the hypothalamus-pituitary-adrenal and gonadal axis that may affect reproductive function by altering the circulating of levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH), inhibin, estrogen, progesterone, and the androgens (Davis et al, 2001, p. 291-296; Schrag and Dixon, 1985, p. 567-592). Reduced fertility among dental assistants with occupational exposure to mercury has been noted (Rowland et al. 1994, p. 28-34; Colquitt, 1995, p. 214). Studies in Hong Kong demonstrated that increased mercury levels were associated with infertility in both men and women (Dickman et al., 1998, p. 165-174). In males, mercury can have adverse effects on spermatogenesis (Boujbiha et al., 2009. p. 81-89), epididymal sperm count, and testicular weight. Evidence also exists linking mercury with erectile dysfunction (Schrag, 1985, p. 567-592). In females, mercury has been shown to inhibit the release of FSH and LH from the anterior pituitary which in turn can affect estrogen and progesterone levels leading to ovarial dysfunction, painful or irregular menstruation, premature menopause, and tipped uterus (Chen et. al. 2006, p. 1080-1085). There is good evidence linking mercury with menstrual disorders including abnormal bleeding, short, long, irregular cycles, and painful periods (Davis, 2001, p. 291-296).

Mercury exposure and male reproduction, semen quality and male mediated reproductive outcome

Table 2. Mercury exposure and male reproduction

Exposer	**Effects**
Blood Hg levels & semen quality in sub-fertile men	Sperm concentration, morphologically normal, motility, curvilinear & straight-line velocity, average path velocity, & amplitude of lateral head displacement, reduced insignificantly with higher blood Hg level (Leung et al, 2001, p. 75-7)
Semen quality, reproductive hormones & environmental Hg exposure	Environmental Hg exposure in Greenlandic & European men with median blood Hg level up to 10 ng ml. (-1) not link with hostile effects on male reproductive biomarkers (Mocevic et al., 2013, p. 97-104)
Urinary metal (As, Cd, Cobalt, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Zn, Molybdenum, Selenium) & sperm DNA damage	Urinary Hg & Ni linked with increasing trends of tail length, and Mn linked with tail moment. This advice that environmental exposure to Hg, Mn, & Ni related with sperm DNA damage (Zhou et al., 2016, p. 68-73)

Pre-conceptional Hg exposure & DNA methylation of imprinting genes H19, in human sperm DNA	Environmental Hg exposure related with altered DNA methylation at imprinting gene H19 in sperm, implicating in susceptibility of sperm for environmental insults (Lu et. al., 2018, p. 13)
Correlated semen quality with hair' Hg level	Hair' Hg level positively linked with sperm concentration, count, & progressive motility. These relations stronger in men with fish consumption. Semen volume & morphology non-significantly related to hair Hg levels (Minguez-Alarcon, et. al., 2018, p.174-82)
Predatory fish usage related with high blood Hg level & semen quality	Linked with lower sperm count & normal morphology. Predatory fish might be a risk factor for higher Hg level that might affect semen quality (Ai et al, 2019, p.19425-33)
Spontaneous abortions among wives of workers exposed to Hg vapor occupationally	An elevation of SAbs with elevation of Hg in fathers' urine before pregnancy. At high levels above 50 µg/L the SAb risk becomes doubles (Cordier et.al, 1991, p.375-81)

Mercury exposure on female reproductive system

Table 3. Mercury exposure and puberty, menstruation, menopause and pregnancy

Exposure	Effects
Women (dentists & dental assistants) exposed to metallic mercury	A significant, risk amid hair' total mercury labels (TMLs) & reproductive failures, Relation with menstrual disorders was significant (Sikorski et al, 1987, p.551-7)
Reproductive risks in female workers exposed to low-level metallic mercury	Low-level long-term Hg exposure brought significantly more dysmenorrhoea, hypomenorrhea at above 0.06 mg/m² of Hg level, & below this, menstrual cycles, quantity, duration did not alter significantly. Rates of PTB, SAb, still birth, fetal death, & pregnancy snags in group exposed to 0.06-0.1 mg/m³ of Hg & control was insignificant (Fu et al, 1993, p.9-347)
Meta-analysis on the reproductive effects of Hg exposure in female workers	Causes dysfunction of menstrual period, cycle, blood volume, dysmenorrhea & cause hostile outcomes, ie., pregnancy-induced hypertension, stillbirth, LBW & birth defects (Pan et al, 2007, p.1215-8)
Menopause & blood Hg level	Blood Hg was lower significantly in postmenopausal than premenopausal women (Yuk et al, 2014, p.162)
Prenatal maternal arsenic & Hg exposure & birth outcomes in artisanal & small-scale gold mining (ASGM) subjects.	In ASGM areas, risk of hostile birth outcome elevated with increasing total-As & total-Hg exposure. SAb, stillbirth & PTB significantly linked with elevated total-As, while elevated Hg significantly linked with stillbirth & congenital anomalies (Nyanza et al, 2020, p. 137)

Table 4. Dental amalgam' mercury exposure and pregnancy

Exposure	Effects
Reproductive history of dentists & dental assistants	No elevated rates of congenital abnormalities or SAb in children of men & women exposed to low v/s high dose of Hg in dental setting (Brodsky et al 1985, p.779-80)
Assessed links amid exposure to amalgam fillings & pregnancy outcome	No significant associations amid total teeth with amalgam fillings & early, late PTB, LBW, malformation, or stillbirth babies (Lygre et al, 2016, p.442-9)
Exposures to Hg during amalgam preparation.	Women with more Hg exposure were less fertile. The fecundability (chance of conception at each menstrual cycle) of women those prepared 30 or more amalgams/week have 63% chance of conception than control (Rowland et al, 1994, p.28-34)
Pregnant dental professionals	Suffered with higher odds of developing spontaneous abortion, pre- eclampsia, and babies smaller for gestational age and this may be connected to oxidative stress induced by mercury (El-Badry et al, 2018, p.113-9)

Table 5. Sea food/fish intake related mercury exposure and effects

Exposure	Effects
Birth anthropometry, placental weight and gestational length and hg	Prenatal Hg exposure by seafood may be related with lower placental & fetal growth (Murcia et al, 2016, p.11-20)
Consumption of seafood in pregnancy	Hg exposure is undesirably related with birth weight. Seafood usage in pregnancy not to be avoided but find at what level Hg exposure might exceed the risk of seafood (Vejrup et al,2014, p. 2071-80)
Consumption of seafood in pregnancy	Hg exposure is undesirably related with birth weight. Seafood usage in pregnancy not to be avoided but find at what level Hg exposure might exceed the risk of seafood (Vejrup et al, 2014. p. 2071-80)
Maternal seafood consumption	Maternal seafood intake linked with Hg level. No association amid Hg level & fetal growth, except negative relation with biparietal diameter (Drouillet – Pinard et al, 2010, p. 1096-100)
MeHg level & fish consumption	Blood MeHg level significantly more in infertile than pregnant women & consistent with fish consumption (Lei et al, 2015, p. 411-7)
Hg exposure & birth outcome	About 15, 7% of subjects had PTB & 8, 1% delivered LBW. Lower hair Hg exposure (lowest tertile < 2.34

	μg/g), related with LBW while no link amid hair Hg & PTB (Baldewsingh et al, 2020, p. 4032)
Total hair mercury (HHg) level as a pointer of fish usage & MeHg exposure	Birth weight considerably different among groups but not exhibit a consistent pattern with fish usage (Marques et al, 2013, p. 2150-63)
Methyl mercury exposure from fish & sea mammals' consumption	Inorganic Hg in aquatic sediments methylated by microorganisms & Stored in aquatic food. Fish users do not reveal hostile effects. Even, some tests show beneficial impacts (Clarkson and Strain, 2003, p.43s-1539s)

Fetotoxicity

In addition to reproductive issues, mercury is also associated with the fetotoxicity which can present as miscarriage, spontaneous abortions, stillbirth, and low birth weights (Yoshida, 2002, p.79-88). In the neonate, mercury exposure during pregnancy has been linked to neural tube defects, craniofacial malformations, delayed growth, and others (Yoshida, 2002, p.79-88). Mercury is known to cross the placenta where it can inhibit fetal brain development resulting in cerebral palsy and psychomotor retardation in the latter stages of development (Castoldi et al, 2001, p.197-203; Burbacher et al, 1984, p.18-24). In primates maternal MeHg blood levels were moderately related to increased abortion rates and decreased pregnancy rates (Myers, 1998, p.841-847). Embryopathic effects of MeHg in humans have also been reported. Fetal autopsies indicated a generalized hypoplasia of the cerebellum, decreased number of nerve cells in the cerebral cortex, marked decrease in total brain weight, abnormal neuron migration, and brain centers and layer deranged organization. MeHg easily enters through the placenta and damages the brain of the fetus. Many exposed fetuses go on to develop infantile cerebral palsy and there may be a relation with the development of neonatal disease. Babies may be born with a variety of birth defects. A study of 64 children exposed in utero to mercury and showing mercury associated damage included the following signs and symptoms: mental retardation (100%), primitive ref lexes (100%), strabismus (77%), cerebellar ataxia (100%), dysarthria (100%), chorea and athetosis (95%), deformed limbs (100%), hyper salivation (95%), epileptic attacks (82%), and growth disorders (100%) (Choi et al, 1978, p.719-733). Mercury inhibits the Trans membrane transport of nutrients including selenium in the placenta. In animal experiments it has also been shown that there is a much higher accumulation of mercury in the fetal brain tissue than in the maternal brain tissue (Harada, 1999, p.249-256).

Conclusion

Numerous literature data analyzed in this Review indicate negative effects of both organic and inorganic elemental Hg in relation to fertility, reproductive health and pregnancy outcome. Most of the analyzed literature referred to experiments on animals, birds and fish due to the difficulty of doing such studies in human beings. Exposure to inorganic or elemental Hg mainly occurs in professional groups, such as dental stuff, industrial workers producing thermometers, thermostats, dental amalgams and chloralkali workers. Methyl mercury enters the human body with fish through the food chains. An example of Hg exposure is the Minamata disease. The cause of the disease was the prolonged release of inorganic Hg into the water of Minamata Bay, which was converted by the microorganisms to MeHg. The effects of Hg on the reproductive function of human beings are manifested in both men and women. Mercury can alter the shape, movement of sperm and decrease its quantity and quality. In men exposed to Hg, a reduction in erection, quality of sexual acts and ejaculation was found. Research indicates that Hg influences the levels and function of estrogen and reduces fertility in women. Mercury exposure has a relation with the polycystic ovary syndrome, premenstrual syndrome, dysmenorrhea, amenorrhea, premature menopause, endometriosis, benign breast disorders and abnormal lactation. In pregnant women, Hg passes through the placental membrane, which can cause spontaneous abortions, premature births, congenital disabilities and retardation of fetus development. Future perspectives involve research to prevent risk factors for congenital anomalies and identify risk factors. Abandoning the use of dental amalgam, which is the essential source of Hg vapor exposure in the general population, would be an important international measure in the decrease of Hg exposure.

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