

# The Effects of Dental Amalgam Toxicity on Health and Nutritional status

Louay M Labban<sup>1</sup>, Mahmoud M Alshishkli<sup>2</sup>, Ahmad Alkhalaf<sup>3</sup>, Zeina Malek<sup>4</sup>

## Abstract

Amalgam is a combination of metals that has been the most popular and effective filling material used in dentistry for the last 150 years. Although it sometimes is called “silver amalgam,” amalgam actually consists of a combination of metals. These include silver, mercury, tin and copper. Small amounts of zinc, indium or palladium also may be used.

However, its popularity as restorative material is decreasing nowadays due to concerns about unfavorable health effects and environmental pollution. Researchers agree that amalgam restorations leach mercury into the mouth, but consistent findings are not available to report whether it has any significant health risk. The American Society of Dental Surgeons (ASDS) in the year 1843, declared use of amalgam to be malpractice because of the fear of mercury poisoning in patients. In 1859, the American Dental Association (ADA) was founded and it did not forbid use of amalgam. The ADA position on the safety of amalgam has remained consistent since its foundation. In 1920s inferences were made that mercury was not tightly bound in amalgam so its use was discouraged. In this review, we will show the convincing evidences pointed out to adverse health effects due to dental amalgam restorations.

**Keywords:** Amalgam, Composites, Toxicity, Multiple sclerosis, Creatinine, Renal function, Hypersensitivity

## Introduction

Mercury is available in environment and humans are routinely exposed via air, water, and food<sup>(1)</sup>. Exposure to mercury in human individuals with amalgam restoration occurs during the placement or removal of dental restorations. The exposure to mercury from restoration depends on the number and size of restoration, composition, chewing habits, food texture, grinding, brushing of teeth, and many other physiological factors. The organic compounds of mercury such as methyl mercury are readily absorbed by many organisms and accumulate as it passes into food chain. Studies have shown that mercury released from amalgam restorations is absorbed and accumulated in various organs such as kidney, brain, lung, liver, gastro-intestinal tract and the exocrine glands the organic form of mercury was also found to have crossed the placental barrier in pregnant rats<sup>(3)</sup> and proven to cross the gastrointestinal mucosa when amalgam particles are swallowed at the time of amalgam insertion or during removal of old amalgam fillings, whereas the inorganic form of Mercury ions ( $Hg^{+2}$ ) circulate into the blood stream but hardly cross the blood–brain barrier and placental barrier<sup>(4)</sup>.

Various diagnostic methods exist to detect the level of mercury in body, including tests for blood, urine, stool, saliva, hair analysis, and others. These tests may determine if mercury is in the body and/or if it is being excreted. A study conducted by measuring the intraoral vapor levels over a 24-h period in patients with at least nine amalgam restorations showed

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<sup>1,2,3</sup>TeSham academy, Damascus, Syria.

<sup>4</sup>Syrian Private University, Faculty of Medicine, Damascus, Syria.

**Correspondence:** Dr. Louay M Labban, TeSham academy, Damascus, Syria.

**E-mail Id:** drlouay@gmail.com

**Orcid Id:** <http://orcid.org/0000-0002-0308-5148>

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that the average daily dose of inhaled mercury vapor was 1.7 µg (range from 0.4 to 4.4 µg), which is approximately 1% of the threshold limit value of 300 to 500 µg/day established by WHO, based on a maximum allowable environmental level of 50 µg/day in the workplace<sup>(5)</sup>. According to Berdouses *et al.* mercury exposure from amalgam can be greatly increased by personal habits such as, chewing and brushing<sup>(6)</sup>.

Both methylmercury and inorganic mercury can also be measured in breast milk. The relative proportions of these species depend on the frequency of fish consumption, dental amalgam status, and occupational exposures. In a study for comparison of hair, nails, and urine for biological monitoring of low level inorganic mercury exposure in dental workers, the data suggested that urine mercury remains the most practical and sensitive means of monitoring low level occupational exposure to inorganic mercury<sup>(7)</sup>.

Mercury is capable of crossing through lipid layers at membrane barriers of the brain and placenta. This fact has become the basis for claims of neuromuscular problems in patients with amalgam restorations. Maternal amalgam restoration results in *in utero* exposure to low levels of elemental mercury. In a prospective study consisting of 72 pregnant women, it was found that the number and surface areas of amalgam restorations positively influenced the concentration of mercury in amniotic fluid. To find co-relation between mercury exposure from amalgam restorations placed during pregnancy and low-birth weight 1,117 women with low birth weight infants were compared with random sample of 4,468 women who gave birth to infants with normal birth weight. Women (4.9%) had at least one amalgam restoration placed during pregnancy. In a study conducted by Daniels 90% of the women received dental care during pregnancy. Having more restorations placed at time of conception did not negatively affect pregnancy or birth outcome. Mean umbilical cord mercury concentration was slightly higher in women who had dental care<sup>(10)</sup>.

Studies have not associated the exposure from amalgams with health outcomes among children; however, it contributes to the contamination of air when the bodies are cremated. In some countries, amalgam is being replaced due to the precautionary principle by mercury-free filling materials. In other countries dental amalgam is still in use, mainly due to financial aspects<sup>(11)</sup>.

The Children's Amalgam Trial is a randomized trial, to address potential impact of mercury from amalgam restorations on neuropsychological and renal function in children. Bellinger *et al.*<sup>(12)</sup> conducted a study on 534 New England children, aged 6–10 years for 5 years. All subjects were in need of at least two posterior occlusal restorations. Participants were randomized to receive either amalgam or

composite restoration at baseline and at subsequent visits. The primary endpoint was to assess the 5-year change in IQ scores. Secondary endpoints included measures of other neuropsychological assessments and renal functioning. In the 5-year follow-up period the investigators conducted multiple assessments of IQ score, memory index, and urinary albumin.

A significant association was detected between amalgam exposure and the continuous vibro-tactile sensation response. The study reported that this association was a subclinical finding that was not associated with symptoms, clinically evident signs of neuropathy or any functional impairment.

In the Children's Amalgam Trial, one of the secondary endpoints included renal functioning. The investigators assessed changes on markers of glomerular and tubular kidney function and urinary mercury levels. The 7 years of longitudinal data provide extensive evidence about relative safety of amalgam in dental treatment. Substantial amalgam exposure did lead to creatinine adjusted urinary mercury levels that were higher in the amalgam group. Children with amalgam restorations had slightly elevated levels of mercury in their urine, measuring on average 1.5 µg/L of urine for the first two years and levelling off to 1.0 µg/L or less thereafter. However, these values fall within the background level of 0–4 µg/L, which is usual for an average person not exposed to industrial or other known sources of mercury<sup>(13)</sup>. The finding suggested that there may be sex-related differences in mercury excretion. They found that females have significant increase in the rate of mercury excreted in urine than males. Thus, this association might confer a lower mercury toxicity risks in females<sup>(14)</sup>. Dunn *et al.*<sup>(15)</sup> evaluated scalp, hair, and urine mercury content of children collected over the 5-year period, mean hair mercury level was 0.3–0.4 µg/g and mean urinary mercury level was 0.7–0.9 µg/g creatinine. The authors reported that use of chewing gum in the presence of amalgam restoration was a predictor of higher urinary mercury levels. Data suggested that amalgam-associated mercury exposure might be reduced by avoidance of gum-chewing in the presence of amalgam restorations.

Sixty children were studied to assess urinary mercury excretion and its relation to amalgam restoration and fish consumption. Children with amalgam restorations had significantly higher urinary mercury levels compared to children with non-amalgam restorations.

An investigation on 20,000 people in the New Zealand Defence Force between years 1977–1997 was done to find out association between amalgam restorations and disorders related with nervous system and kidney. A slightly elevated risk for multiple sclerosis was reported, but may have been due to confounding variables. The association

between amalgam and multiple sclerosis was assessed via a systematic review and meta-analysis. Three case control studies and one cohort study met their inclusion criteria. The meta-analysis revealed a slight significant increase between the presence of amalgam restorations and multiple sclerosis<sup>(17)</sup>.

Amalgam is capable of producing delayed hypersensitivity reactions in some individuals. These reactions usually present with dermatological or oral symptoms. The constant exposure to mercury in amalgam restorations may sensitize some individuals, making them more susceptible to oral lichenoid lesions. These oral lesions are rarely noticed by the affected individuals and cause no discomfort. There is evidence that a certain percentage of lichenoid lesions are caused by amalgam restorations<sup>(18)</sup>. Hence corrosion of amalgam restoration or perhaps the biofilm present on such restorations may contribute to the development of hypersensitive reaction rather than material itself. Symptoms of an amalgam allergy include skin rashes in the oral, head and neck area, itching, swollen lips, localized eczema-like lesions in the oral cavity. These clinical signs usually require no treatment and will disappear on their own within a few days of exposure. However, in some instances, an amalgam restoration will have to be removed and replaced with alternate restorative material. The replacements have led to significant improvements<sup>(20)</sup>. Although mercury allergy is rare but sometimes hypersensitivity to it may lead to dermatitis or type IV delayed hypersensitivity reactions most often affecting the skin as a rash. Amalgam possesses greater longevity than composite. However glass ionomer cements and composite serves better than amalgam when conservative preparation is recommended due to increased demand for aesthetic restorations<sup>(22)</sup>. The effects they cause vary depending on the substance and on the type of body tissue with which they come into contact<sup>(23)</sup>.

Composites were seven times likely to require replacement than amalgam<sup>(25)</sup>. Though use of amalgam has decreased during the past few years, more studies on safety of composites or other aesthetic materials with long-term follow-up of are necessary before they can be considered a definitive alternative for amalgam.

**Conflict of Interest:** None

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