



## **The Hazardous Effects of Dental Amalgam Fillings in Human Body: A Systematic Review**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

The Dental amalgam used in the dental fillings is basically an alloy of mercury (Hg). The amalgam is one of the most commonly used and versatile restorative material. Since more than 150 years this alloy of mercury, that is amalgam is used for it been economical, easy to use, durable, high strength and bacterio-static characteristics. Due to environmental pollution, detrimental health its use is decreasing in recent times. Also its not so appealing like the other materials used that resemble the tooth color. The tooth coloured restorative materials are recommended by both the doctor and the patient. Many researchers suggested that over the period of time the mercury from the filling might leach into the mouth. Thus in this study a detailed review of all the literature available online is done to understand the hazardous effects of dental amalgam fillings in the human body. The systematic literature search using Scopus, PubMed, EMBASE and Web of

Science electronic databases was done using PRISMA. The experiments conducted in Sheep and monkey suggested the penetration of amalgam into the jaw bone of the patient with dental restorations. Constant exposure of mercury at lower levels can also lead to multiple sclerosis, rheumatoid arthritis and systemic lupus erythematosus. Most commonly reported renal dysfunction due to the dental amalgams are Tubular and Glomerular damage of the kidneys.

*Keywords: Dental Amalgam; Mercury; Hazardous effects; restorative dental material; health issues.*

## 1. INTRODUCTION

Dental Amalgam is used all across the world for the restoration of the teeth. The dental amalgam is an alloy that contains mercury along with copper, silver and tin [1]. On reaction of the metal powders with the liquid mercury, an alloy is formed that is stable, and flexible, easy to shape and pack [2]. The dental amalgam fillings are often referred as the silver fillings because of its look and appearance. It was reported that in Indonesia, 80% of the dentist uses amalgam as a restorative material [3].

Although many studies reported that there is no evidence of any harmful effects with amalgam when used as a restorative material; the Medical community objects to this. They suggest the leaching of mercury in the mouth and the exposure of the human body to the mercury. The Doctors suggests that high concentration of mercury could cause damage to heart, kidneys and brain [4].

In the year 659, the Chinese Literature recorded the first use of dental amalgam for the restoration of the teeth. More than 70% of the restorations were done using dental amalgam in 1970s. However, in the recent times the use of amalgam is decreasing. But still in several parts of the world it is used as an alternate restorative material due to its strength and flexibility [5].

Louis Regnart was called as the 'Father of Amalgam'. He added mercury to the boiled mineral cement that reduced the temperature of pouring cement onto a tooth. GV Black in the year 1890, proposed a formula for Amalgam to be clinically acceptable, that remained unchanged for about 70 years. In 1963, copper was added to amalgam that improve its strength. The Amalgam used in modern era has about 42% to 45% mercury concentration in a pre-capsulated alloy.

In 1843, began the Amalgam war in which the American Society of Dental Surgeons (ASDS) was founded in New York that prohibited the use

of Amalgam with the fear of mercury poisoning in the dentists and patients. By 1856, the Amalgam war ended due to dis-abundance of the organization. Later in 1859, the American Dental Association (ADA) was formed that did not forbid the use of amalgam. In 1991, FDA and the NH-NIDR was formed that claimed that Amalgam had no health hazards.

The mercury from the Amalgam is released only when placing and removing the dental restorations. Only during the reaction, the mercury is released. When the reaction is completed, the mercury release is ceased. The mercury that is leached during the process is far less when compared to the threshold limits of mercury exposure.

For the dentist, 80% of vapours of the metallic mercury can be inhaled and reaches to the alveoli of the lungs. The complex organic compounds of the mercury gets accumulated while passing down the food chain. Many researches was carried on the mercury exposure in monkeys and reported the accumulation of mercury in different organs of Monkey. In an experiment in pregnant Rats, it was recorded that the organic mercury passed the placenta barrier and reached the feteus. Whereas the studies reported that the in-organic form of mercury circulated in the blood but was unable to pass through the blood brain barrier and the placenta barrier. The average half life of mercury in humans is only 55 days. Berdouses reported that the exposure to mercury is increased in the human body due to their increased personal habits of the patient like chewing and brushing teeth. The atomic fluorescence spectrophotometry was used to monitor the rapid mercury release detection in the patient's blood and urine.

Although there are many advantages of the dental amalgam as a restorative material, still few studies records the toxic effects caused by the mercury present in the amalgam. Some researchers reported the adverse effects of amalgam to the body like causing neurological

problems and chronic fatigue. But the American Dental Association ADA, claims that the dental amalgam is harmless [6].

To understand and discuss about all the possible outcomes, we selected this controversial topic to study. Thus in this review we will study and understand about the dental amalgam and its hazardous effects by carrying a systematic review.

### 1.1 Aim and Objectives

The main aim of this study is to systematically review the studies that reported the hazardous effects of dental amalgam fillings.

### 1.2 Specific Objectives

1. Reviewing about the history of dental amalgam
2. Understanding the advantages of using dental amalgam in using as a restorative material.
3. Identifying the hazardous effects of the dental amalgam.
4. Carrying the online literature review using the different databases to know the relationship.

## 2. METHODOLOGY

### 2.1 Study Design

A systematic review of literature related to the hazardous effects of dental amalgam in the human body is done. The review was done in accordance with the guidelines of PRISMA (Preferred Reporting Items for Systematic Review and Meta-analysis). A complete review of all the articles is to be carried out using databases like: SCOPUS, PUBMED, EMBASE and WEB OF SCIENCE. The MESH terms (General controlled vocabulary) and keywords to be used were selected.

### 2.2 Eligibility Criteria

All the original articles related to the content of the hazardous effects of dental amalgam, along with peer reviewed articles. Studies were excluded when abstracts from the conferences and abstracts were written in non-Latin language. Any consensus between the authors will be resolved using the eligibility criteria. All the references of the selected articles is to

be reviewed manually to account the exempted articles from the electronic databases.

### 2.3 Extraction of Data

All the main findings of articles related to the study of hazardous effects of dental amalgam in human body is to be analyzed and critically reviewed by the authors. It included name of the authors, year of publication, study type, hazardous effects reported, and their findings.

### 2.4 Selection of Articles

The literature search using Scopus, PubMed, EMBASE and Web of Science electronic databases was done using PRISMA. The systematic review of literature was carried out in English language. In the initial term of reviewing, no filters were applied to make sure all the studies are available for successive screening. Later on filters like human and animal studies, only English language studies were added.

## 3. RESULTS

Prenatal exposure to dental amalgam in the Seychelles Child Development Nutrition Study: associations with neurodevelopmental outcomes at 9 and 30 months Neurotoxicology. 2012 Dec;33(6):1511-1517

## 4. DISCUSSION

### 4.1 Health Hazards in Children

A randomized trial was conducted to study the impact of Mercury on the neuropsychology and renal function in children who are exposed to Mercury. According to this study, no significant difference was seen in the neuropsychological or renal effects observed in the children with amalgam restoration. Many researchers reported that there is no significant association between the neuropsychological outcomes and the Mercury exposure [19]. According to another study there was a significant association detected between the exposure to Mercury and continuous vibrotactile sensation in children. No decline in test scores of individual children with Amalgam restorations showed when conducted test of memory, attention, velocity of nerve conduction and physical condition. The study concluded that there were no adverse neurological outcomes in children exposed to amalgam [20]. The children with

amalgam restoration showed increased concentration of mercury in their urine. The rate of mercury excreted in urine is more in female child when compared to the male child and hence is correlated with gender difference.

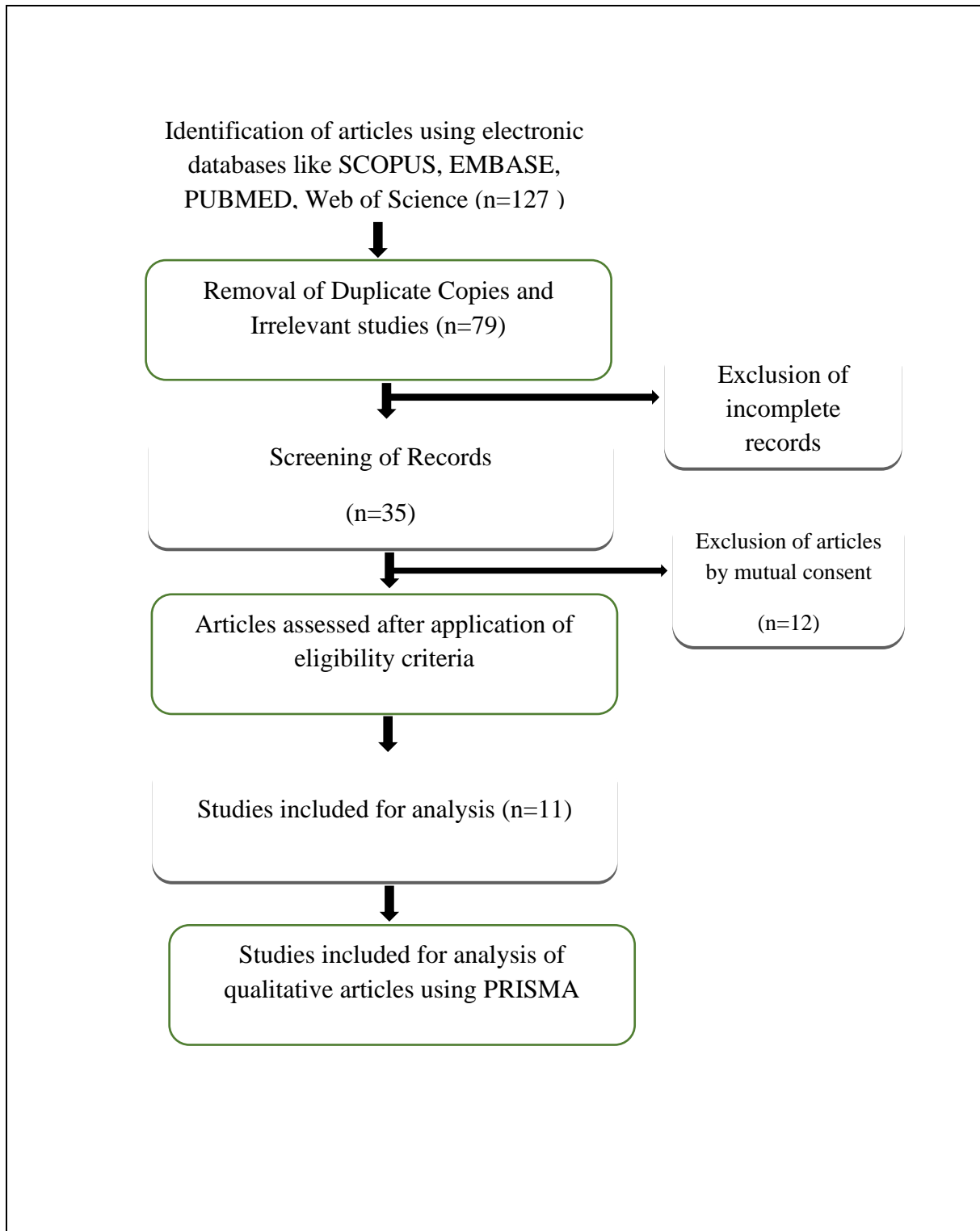


Fig. 1. Study protocol

**Table 1. Systematic review of literature**

<b>Year of publication</b>	<b>Author's name</b>	<b>Published in</b>	<b>Title of study</b>	<b>Hazardous effects of dental amalgam reported</b>	<b>Findings of the study</b>
1975	Kukizaki S. [7]	ShikaRikogaku Zasshi.	Studies on the effects of dental amalgam upon the fertilization and early development of sea urchin eggs	Metal mercury in the medium effects remarkable cytotoxic action upon the development of early embryos; the cleavage and early development were delayed and all of the embryos show deformity	It shows strong cytotoxic action as the metal mercury was incubated, however, the cytotoxic action decreased and almost disappeared in 5 hours after trituration.
1990	Weiner JA, Nylander M, Berglund F. [8]	Sci Total Environ.	Does mercury from amalgam restorations constitute a health hazard?	Amalgam restorations continuously emit mercury vapor, which is absorbed in considerable quantities via the lungs.	Individuals with unusually high emission of mercury from amalgam fillings are at risk.
1992	Widström E, Birn H, Haugejorden O, Sundberg H. [9]	Int Dent J	Fear of amalgam: dentists' experiences in the Nordic countries.	About 70 per cent of the dentists believed that inexplicable symptoms associated with amalgam fillings had a psychosomatic background	About 5 per cent of the respondents were ready to stop using amalgam in the near future.
1995	Eneström S, Hultman P. [10]	Int Arch Allergy Immunol.	Does amalgam affect the immune system? A controversial issue.	Experimental and clinical data strongly indicate that these and other subclinical systemic adverse immunological reactions to dental amalgam metals in humans	In some instances, systemic hypersensitivity reactions to dental amalgam metals, especially mercury, occur at a low frequency among amalgam bearers.
2002	Ylinen K, Löfroth G. [11]	ActaOdontolSc and	Nordic dentists' knowledge and attitudes on dental amalgam from health and environmental perspectives	Most dentists considered amalgam to be a health risk for at least some patients, and a great majority	The majority of dentists in each country wanted to keep dental amalgam as a restorative material even in the future, and they did not want to ban the import of mercury to their home countries.
2004	Bates MN, Fawcett J,	Int J Epidemiol.	Health effects of dental amalgam exposure: a	Associations with medical diagnostic categories, particularly	Results were generally reassuring, and provide only

<b>Year of publication</b>	<b>Author's name</b>	<b>Published in</b>	<b>Title of study</b>	<b>Hazardous effects of dental amalgam reported</b>	<b>Findings of the study</b>
	Garrett N, Cutress T, Kjellstrom T. [12]		retrospective cohort study	disorders of the nervous system and kidney, were examined.	limited evidence of an association between amalgam and disease
2006	Bates MN. [13]	Int J Hyg Environ Health.	Mercury amalgam dental fillings: an epidemiologic assessment.	The preponderance of evidence suggests no renal effects and that ill-defined symptom complexes, including chronic fatigue syndrome, are not caused by amalgams.	dental amalgam effects include inadequate longitudinal exposure assessment and negative confounding by better access to dental care in higher socioeconomic groups
2012	Watson, G. E., Evans, K., Thurston, S. W., van Wijngaarden, E., Wallace, J., McSorley, E. M., Bonham, M. P., Mulhern, M. S., McAfee, A. J., Davidson, P. W., Shamlaye, C. F., Strain, J. J., Love, T., Zareba, G., & Myers, G. J. [14]	Neurotoxicology	Prenatal exposure to dental amalgam in the Seychelles Child Development Nutrition Study: associations with neurodevelopmental outcomes at 9 and 30 months."	Dental amalgam is approximately 50% metallic mercury and releases mercury vapor into the oral cavity, where it is inhaled and absorbed. Maternal amalgams expose the developing fetus to mercury vapor. Mercury vapor can be toxic, but uncertainty remains whether prenatal amalgam exposure is associated with neurodevelopmental consequences in offspring.	no evidence of an association between our primary exposure metric, amalgam surfaces, and neurodevelopmental endpoints. Secondary analyses using occlusal points supported these findings, but suggested the possibility of an adverse association with the MDI for girls at 9 months.
2015	Mortazavi G, Mortazavi SM. [15]	Rev Environ Health	Increased mercury release from dental amalgam restorations after exposure to electromagnetic fields as a potential hazard for hypersensitive people and pregnant women.	reported that increased mercury release after exposure to electromagnetic fields may be risky for the pregnant women. It is worth mentioning that as a strong positive correlation between maternal and cord blood mercury	It can be claimed that the safety of mercury released from dental amalgam fillings is questionable

<b>Year of publication</b>	<b>Author's name</b>	<b>Published in</b>	<b>Title of study</b>	<b>Hazardous effects of dental amalgam reported</b>	<b>Findings of the study</b>
				levels has been found in some studies	
2016	Vähäsarja N, Montgomery S, Sandborgh-Englund G, Ekbohm A, Ekstrand J, Näsman P, Naimi-Akbar A. [16]	J Perinat Med.	Neurological disease or intellectual disability among sons of female Swedish dental personnel.	We found no elevated risk for neurological disease, epilepsy or intellectual disability among the sons of dental personnel during any of the decades studied.	Current use of dental amalgam should not represent an elevated risk for neurological disease or intellectual disability among the offspring of dental personnel.
2017	Maqbool F, Niaz K, Hassan FI, Khan F, Abdollahi M. [17]	J Environ Sci Health C Environ Carcinog Ecotoxicol	Immunotoxicity of mercury: Pathological and toxicological effects.	In this study the sources of Hg and its potentiality for causing toxicity in humans was recorded	Bio-chemical cycling in the environment; its systemic, immunotoxic, genotoxic/carcinogenic, and teratogenic health effects; and the dietary influences; as well as the important considerations in risk assessment and management of Hg poisoning have been discussed
2021	Musliu A, Beqa L, Kastrati G. [18]	Integr Environ Assess Manag.	The use of dental amalgam and amalgam waste management in Kosova: An environmental policy approach.	Existing national regulations on hazardous waste management in Kosova consider the waste from dental health care as hazardous.	New regulations, revised hazardous waste management standards, and new infrastructure for waste treatment and disposal, in compliance with EU regulations, should be developed to create a holistic approach that prevents the adverse effects of amalgam waste.

## 4.2 Health Hazards in Adults

Study conducted in New Zealand reported that there is no significant relation between the adults with amalgam restoration and chronic fatigue syndrome or Kidney disease. Maybe due to the confounding variable, slight increase in risk factor for multiple sclerosis was observed. Another study reported no connection between the patients' symptoms and their Mercury levels in blood saliva and urine [20]. Many studies reported in the presence of multiple sclerosis in patients with amalgam restoration. Authors concluded that the exposure of Mercury is below the tolerable dose stated by WHO, that is 30 micrograms per day. Few reported the delayed hypersensitivity reaction in individuals with amalgam restoration. The hypersensitivity reaction maybe Dermatological/ Oral. Few adverse reactions that were reported are skin rashes in the oral cavity, neck area associated with itching and swollen lips. The hypersensitivity reaction will fade away after sometime of exposure to Mercury. If the condition worsens then the restoration need to be removed and replaced with a different type of restorative material.

## 4.3 Exposure to the Dental Professionals

The dental professionals are at high risk of exposure to inorganic material while handling the amalgam [21]. The authors reported an increased concentration of mercury in the urine of the dental professionals when compared to the normal control group. Arthritis, dry skin, Metallic taste, unsteadiness, sleep disturbances, bloating are few symptoms that are reported due to Mercury poisoning.

In vitro experiment, it was found that mercury is 10 times more toxic when compared to lead. 80% of the mercury can be effectively absorbed by the respiratory system at room temperature. The mercury vapor after entering the cells gets oxidised that inhibits its biological activity. Chelating agents like DMPS, can lead to an increase in mercury concentration in spinal cord. According to the investigations, it was reported that the modern human had 10 to 1000 times more mercury when compared to the ancient humans. It was found in a study that the dental amalgam restorations in human beings caused damage to the DNA in human blood cells that can trigger cancer. A significant oxidative stress in the saliva and blood is seen in the individuals with the amalgam restoration [22].

The breast tissues on evaluation showed an increased concentration of mercury in human beings. Mercury resistance is seen to be developed in the human oral bacteria that can cause antibiotic resistance. The experiments conducted in Sheep and monkey suggested the penetration of amalgam into the jaw bone of the patient with dental restorations. Constant exposure of mercury at lower levels can also lead to multiple sclerosis, rheumatoid arthritis and systemic lupus erythematosus. Also a research on the exposure of mercury and ethyl mercury showed that it causes the phagocytosis of the cells involved in the innate and acquired immune response of human beings. There also exists a relation between the mercury exposure and ectopic eczema and often disappears on detoxification. Constant X leeching of mercury from the dental amalgam can lead to hypertension and myocardial infarction.

## 5. CONCLUSION

Most of the study carried out found the harmful effects of dental amalgam in the kidney functioning in children. But experiments carried out on any animals showed the impairment of renal functions due to the amalgam fillings. Most commonly reported renal dysfunction due to the dental amalgams are Tubular and Glomerular damage of the kidneys. Recent researches and review of literature showed significant role of mercury released from the dental amalgams in causing Alzheimer's disease. In another study it was found that there was a significantly higher Amalgam exposure in individual who suffered from Parkinson's disease when compared to the healthy control group.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

It is not applicable.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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