

# Caries: A Review on Recent Trends and Advances

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**Abstract:** Caries are one of the most common oral diseases in daily life. Its incidence rate increases year by year, and it has excellent harm and poor prognosis. With the development of medical technology, although inevitable progress has been made in preventing and treating caries, it is still clinically impossible to effectively control and treat caries in the early stage of onset. Therefore, researchers still need to deepen the treatment of caries further. According to the literature on caries in recent years, this article systematically summarizes the research progress of caries, mainly discusses the pathogenesis, preventive measures, and treatment methods of caries, aiming to lay a specific foundation for the prevention and treatment of caries.

## 1 INTRODUCTION

Caries is a prevalent oral disease in daily life. It can be seen at any period after the eruption of deciduous teeth. It is mainly manifested as a series of disease states with increasing severity and tooth destruction, from subclinical changes to dentin (Kassebaum, 2015). The World Health Organization (WHO) reviewed the current epidemiological data in many countries in the American Journal of dentistry in

2009, clearly showing that the prevalence of dental caries is increasing significantly and has already affected the coronal and root surfaces of deciduous teeth and permanent teeth in children and adults. The increase in the prevalence of dental caries occurred in groups with low socio-economic status, new immigrants and children. The reason for the increase may be related to the prevention policy. For public health, recognizing oral health and the level of dental caries deterioration is significant (Bagramian, 2009).

Table 1: Age-standardized Prevalence and Incidence Rates and 95% Uncertainty Intervals of Untreated Dental Caries in Permanent Teeth in 1990 and 2010 for Both Sexes Combined.

Region/Country	Prevalence			
	1990		2010	
Global	35.5	33.7–37.6	35.4	33.7–37.3
Asia Pacific, high income	25.1	19.5–32.4	25.2	19.8–31.9a
Asia, Central	38.7	33.5–44.7	38.7	33.7–44.3
Asia, East	34.3	28.7–40.5	34.3	28.7–40.2
Asia, South	41.6	36.0–47.5	40.8	35.9–46.6
Asia, Southeast	34.6	30.7–39.4	35	30.9–39.7
Australasia	19.3	16.4–22.5	19.9	17.0–23.4a
Caribbean	35.5	30.1–41.2	35.9	30.6–42.1
Europe, Central	47.4	42.3–53.3	47.3	41.8–53.1b
Europe, Eastern	43.3	35.1–53.8	43.1	34.3–53.9
Europe, Western	35.3	32.5–38.6	35.8	33.1–39.0
Latin America, Andean	36.3	29.7–43.9	36.3	29.3–44.3
Latin America, Central	34.9	29.1–41.1	34.8	29.1–41.2
Latin America, Southern	44.7	38.1–52.8	44.9	38.1–52.4b
Latin America, Tropical	27.5	21.6–35.6	27.6	21.8–34.7
North Africa / Middle East	34.2	30.2–38.9	34.1	30.2–38.5

Region/Country	Prevalence			
	1990		2010	
North America, high income	22.3	19.2–25.4	22	19.1–25.4a
Oceania	35.4	28.3–44.1	35.2	27.7–43.6
Sub-Saharan Africa, Central	36.3	29.2–45.1	36.4	29.2–45.5
Sub-Saharan Africa, East	32.9	29.4–36.8	32.8	29.6–36.3
Sub-Saharan Africa, Southern	37.1	32.9–41.9	36.9	32.6–41.7
Sub-Saharan Africa, West	31.1	28.5–34.2	31	28.2–33.7
	Incidence			
Global	28,689	27,069–30,381	27,257	25,808–28,928
Asia Pacific, high income	49,883	41,697–59,384	50,197	41,917–59,874b
Asia, Central	34,736	29,982–40,412	34,406	29,231–40,694
Asia, East	19,209	14,923–24,191	19,057	15,042–24,052a
Asia, South	16,229	13,119–19,946	16,293	13,079–19,917a
Asia, Southeast	28,952	24,259–34,644	28,848	24,344–34,263
Australasia	14,857	12,433–17,854	14,029	11,557–16,911a
Caribbean	27,704	23,084–32,666	27,199	22,994–32,431
Europe, Central	47,378	41,509–54,190	46,876	41,146–53,486b
Europe, Eastern	35,208	27,090–45,781	35,184	27,020–45,042
Europe, Western	50,741	46,755–54,816	49,344	45,036–53,912b
Latin America, Andean	47,406	38,624–58,757	47,568	38,857–58,365b
Latin America, Central	25,572	21,473–29,972	25,660	21,751–30,150
Latin America, Southern	35,524	27,175–45,745	35,533	27,168–45,433
Latin America, Tropical	48,751	38,385–61,029	48,151	37,790–59,975b
North Africa / Middle East	24,009	21,006–27,216	23,626	20,646–26,882
North America, high income	60,821	51,817–71,377	62,610	52,773–74,950b
Oceania	28,855	22,265–37,155	28,669	21,527–37,532
Sub-Saharan Africa, Central	27,426	21,270–35,498	27,742	21,109–35,911
Sub-Saharan Africa, East	27,813	24,544–31,702	27,959	24,441–31,790
Sub-Saharan Africa, Southern	29,380	22,735–37,822	28,975	22,290–37,110
Sub-Saharan Africa, West	16,044	14,233–18,039	16,249	14,358–18,166

Prevalence, per 100 population; incidence rate, per 100,000 person-years.

a Indicates a prevalence or incidence significantly lower than the global mean for 2010.

b Indicates a prevalence or incidence significantly higher than the global mean for 2010.

If tooth decay occurs in children or adolescents, it will lead to dentition infection and even tooth loss. It is very important to use fluoride to prevent and control dental caries at this stage. Fluoride can be administered locally by fluorinated water or fluoride salt, or systemic by using dietary supplements (tablets, drops, tablets or gum) (Lampert, 2012). A systematic review of evidence on dental floss use showed that the use of professional floss in first grade children during school reduced the risk of dental caries by 40%, and this benefit was found only during the period of children's deciduous teeth (Hujoel, 2006). There is clear evidence that daily use of fluoride toothpaste has a significant effect on the prevention of dental caries in children (the prevention effect is about 24%). Parents supervise tooth brushing every day, increase the frequency of tooth brushing to twice a day, and use 1500 ppm fluoride toothpaste, which will enhance the effect of preventing caries in children (Rozier, 2010). Silver fluoride diamine is a

safe and effective drug for treating dental caries. A clinical research report pointed out that using silver fluoride diamine can reduce the prevalence of dental caries in children (Llodra, 2005). In another study, 38% silver fluoride diamine was shown to prevent and caries. The preventive effect of silver fluoride diamine applied to caries and that directly applied to other teeth and surfaces is similar. Single-use silver fluoride diamine can not produce a sustained impact, and it is more effective to use it twice a year (Horst, 2016).

a median value of three examiners; b all lesions included; c caries-active children only; d results of two different examiners. PF = prevented fraction (DMFT/dmfs, DMFS/dmfs); LE = level of evidence A-C; SV = supervised tooth brushing (daily or on school days); NS = not statistically significant.

In this article, we mainly summarize the research progress of dental caries, focusing on the pathogenesis, treatment, and prevention of dental

caries, combining existing treatment measures to lay the foundation for the prevention and treatment of dental caries.

## 2 INTRODUCTION TO DENTAL CARIES

Dental caries is a common multi-factor biofilm disease. 60% to 90% of children are affected by it, and it is one of the most common diseases in the world population. The most common symptom of dental caries is tooth pain, loss and so on (Bagramian, 2009).

The oral cavity is a complex environment in which saliva flows continuously in the mouth, and the teeth have multiple tooth surfaces. They are often exposed to the external environment and substances. Microorganisms, host factors (the buffering capacity of saliva and the speed of saliva flow) interact with foods that can ferment carbohydrates. There are bacterial biofilm formation and dental plaque on the surface of teeth. The symbiotic microbiota in the mouth has an important influence on controlling the reproduction of harmful bacteria. The bacterial group in the mouth will change due to changes in the local environment. These changes will lose the balance of the composition of mobile phone biofilm to change the overall metabolic activity of biofilm and then lead to caries (Marsh, 2012). The biofilm formation begins with constructing an acquired salivary membrane (eglycosyltransferases; Gtfs) (Bowen, 2011) is mainly a film layer formed by salivary proteins and bacterial enzymes. Gtfs can directly adhere to some bacteria, and it can also synthesize glucan, thereby increasing the ability to adhere to bacteria (Bowen, 2011). The development of cariogenic biofilms is mainly related to streptococcus mutants and sucrose (Leme, 2006). In addition, the local demineralization of pathogenic bacteria on the tooth surface will eventually lead to the occurrence of caries. This process is related to the following factors: (1) The surface of the patient's teeth is susceptible to the retention of food residues or deep pits and fissures caused by dental defects. (2) The number of pathogenic bacteria in dental plaque is sufficient. (3) Sufferers often eat fermentable carbohydrates. (4) Saliva decrease in oral (Murray, 1989; Marsh, 2006; Selwitz, 2007).

The nutrition obtained by the human body may have a systematic and local effect on dental caries. Optimal energy and nutritional intake are critical to tooth development. From the fetal stage, it is an

important period for the formation of the best teeth, because this period is accompanied by the absorption of energy and nutrition, and ends around the age of six. Nutritional deficiency can affect tooth mineralization, making teeth more prone to caries (Hujoel, 2017). The local effect can be understood as carbohydrates in tooth biofilm decompose by microorganisms, and microorganisms release acidic products, in which the primary acids are lactic acid and acetic acid. Acid production in the caries-promoting environment does not change significantly among the different fermentable carbohydrates. This depends on the local diet structure and is primarily affected by the complex environment in the oral cavity (biofilm composition, diet structure, saliva, and saliva). With age, periodontal atrophy, and root zone exposure, the relationship between caries and carbohydrates may change accordingly. The dietary recommendations for children and adolescents should be compared with those for the elderly. The degree of mineralization of teeth is affected by many micronutrients. Vitamin D, calcium, and phosphate play an essential role (Hujoel, 2013). Most organizations globally believe that vitamin D deficiency may lead to teeth hypoplasia or poor tooth mineralization.

## 3 CAUSES AND TREATMENT OF DENTAL CARIES

Caries is frequent bacterial damage to the tooth's hard tissue. Changes in the patient's oral environment can lead to tooth decay, resulting in tooth pain, tooth sensitivity, and even pulp and periapical lesions, resulting in infection, osteomyelitis, and cysts (31). Usually, the teeth of caries patients will change as follows: (1) the color turns yellow and black (2) the appearance defect (3) there are infected tissue and food debris in the caries hole (4) the bottom of the caries hole is softer than regular teeth (32).

The latest theories on the etiology of dental caries believe that oral pathogenic bacteria, cariogenic food, susceptible host of dental caries and long enough infection time are fundamental causes of dental caries. The initial stage of caries begins with the formation of dental plaque. This is because the bacteria in the plaque metabolize sugar to multiply and grow, and produce acidic substances, which dissolve the mineral components of the teeth, thus inducing caries (demineralization) (33). If peoples eat more sugary foods and do not clean properly, it will cause sugar to remain in the oral cavity. Eventually,

bacteria decompose the sugar to produce acidic products and cause tooth corrosion. Although the oral flora is in a balanced state under normal circumstances, the deterioration of the oral environment, the decline of immunity, and the reproduction of harmful flora will cause the balance of the oral flora to be broken, which in turn leads to the formation of dental plaque.

Caries can be divided into superficial, medium, and deep caries according to the extent of the disease. Among them, patients with surface caries rarely have apparent symptoms. Patients with moderate caries have symptoms of tooth sensitivity. And deep caries can see noticeable cavities. According to the location of the lesion, it can be divided into enamel caries, dentin caries, cementum caries, root caries, pit and fissure caries, smooth surface caries, and adjacent surface caries. Cementum caries are common in middle-aged and older adults, and root caries is common in middle-aged people. According to the course of the disease, it can be divided into acute, chronic, and secondary caries. Children and adolescents are more common in aggressive caries (Van, 2021), and the progress of violent caries is about to intervene in time (Khong, 2021).

The caries treatment usually uses a turbine head to remove the decay and then a polymer material for filling. Generally, the photosensitive composite resin is used for light-curing/light curing in the tooth body to bond with the tooth tissue. In the case of tooth shape defects (single tooth surface functional defect), inlay repair is used to restore the original shape and function. If there are multiple facial defects, the high inlay is selected for repair (the material selected for inlay is generally zirconia). Study on the preventive effect of fluoride-containing paint and fluoride-containing foam on children's deciduous tooth caries (Wu, 2021). This treatment needs to make an intraoral dentition model, but the cost is relatively high. Laser treatment is now a more advanced treatment method. When the turbo drill bit is working, it will cause discomfort to the patient, and the noise it produces exceeds the human auditory sensitivity, which will cause discomfort to patients (Xiong, 2021). Laser treatment is a non-contact treatment. When decayed, the dentin is cauterized, and no fluid flows out. The solid-state laser cutting tooth tissue is more efficient than the bur to rot. Under the intervention of solid-state laser energy, the diseased tissue is decomposed, and under the action of external water scouring, the cavities cavity is cleaned up. The surrounding healthy tooth tissue is not damaged during this process, and the treatment process is more comfortable. In addition, the laser can generate a large number of free

radicals without stimulating the dental pulp and can reduce the inflammation of the dental pulp. In addition, the laser will also increase the resistance of tooth enamel to acid and caries.

In addition, for patients of lower age, general anesthesia can be adopted (Xiong, 2021). Studies have shown that general anesthesia can effectively eliminate fear, reduce the patient's stress response, and increase the patient's degree of cooperation (Jiménez-Ramírez, 2021).

## 4 PREVENTION OF CARIES

The prevention of dental caries depends on all aspects of life, mainly including the following points.

### 4.1 Personal Prevention

For the prevention of dental caries, the prevention of dental caries is closely related to the individuals. Only when individuals actively maintain the oral environment can they effectively prevent the occurrence of caries.

Individuals need to develop good oral hygiene habits, such as brushing teeth in the morning and evening, rinsing mouth after eating, and minimizing or even avoiding eating acidic foods to irritate the mouth. Excessive sugar intake is a significant cause of caries, so reducing high-sugar foods, such as sugar and chocolate is necessary. In daily life, People should try to reduce the consumption of hard food and pay attention to calcium intake. In addition, eat more high-fiber foods to improve your immunity (Taiwan defense forces Caries prevention: public health practice of caries prevention, 2012).

### 4.2 Family Prevention

Compared with personal prevention, family prevention plays a role in supervision. To help family members develop good habits, patients can put up a slogan about brushing their teeth in the morning and evening as a reminder near the sink. Parents can reduce the cost of foods with high sugar content, such as chocolates when having family dinners or go shopping. For families with children at home, parents need to supervise the children to ensure that they brush their teeth in the morning and evening, and at the same time actively pay attention to the children's oral hygiene. The elderly can drink more tea daily for families with older adults because tea is rich in fluoride ions, effectively preventing caries. For people with inconvenient hands and feet, they can use

mouthwash or assisted tooth brushing to maintain oral cleanliness, thereby preventing the occurrence of caries (Lu, 2002).

### 4.3 Community Prevention

Communities can propagate post-dental caries' hazards, causes, and prevention methods on the propaganda board and regularly carry out popular science education on dental caries prevention to community residents. At the same time, community clinics can also hold lectures on widespread science knowledge related to caries prevention (Deng, 2009). In addition, Communities can also carry out related activities (such as a "teeth-care day") to convey the awareness of oral hygiene safety and prevention to community residents, and integrate the concept of caries prevention into life and arouse everyone's enthusiasm for teeth-care (Taiwan defense forces Caries prevention: public health practice of caries prevention, 2012).

### 4.4 Government Intervention

The government can formulate relevant policies to show the concept of teeth-care to people across the country and encourage the development of related products to prevent caries, such as fluoride toothpaste. And government can actively carry out lectures about oral hygiene, and conduct treatment programs such as pit and fissure sealing for young people. These measures can reduce the occurrence of caries (Duan, 2011).

### 4.5 Materials of Preventive Caries

#### 4.5.1 Fluoride Toothpaste

Fluoride toothpaste is a good material for preventing caries, and it contains fluoride ions. When the appropriate fluoride ion concentration enters the human oral cavity through toothpaste as a medium, it will react with the tooth enamel to form a type of fluorapatite, forming a protective film on the tooth shell, thereby reducing the effect of dental plaque on the enamel. In addition, fluoride ions can inhibit the adhesion of cariogenic bacteria on the teeth and reduce the number of bacteria (Rozier, 2010).

#### 4.5.2 Resin and Glass Ion

Resin and glass ions are the primary materials for pit and fissure sealing. They are also unique polymer materials for dentistry, which can effectively prevent

the occurrence of caries (Autio-Gold, 2008). The effects of resin and glass ionomer in preventing dental caries are different. The advantage of the resin material is that it has higher strength and patients do not need to fasting for solids and liquids after use. However, the treatment process of resin materials is relatively cumbersome. If the moistureproof layer in the mouth is poor, it may lead to the invalidation of groove closure. The strength of the glass ionomer material itself is slightly weaker than that of the resin material. However, with the development of material technology, it is now possible to combine resin and glass ions to form a reinforced glass ion material, which can slowly release fluoride ions around the tooth to achieve sealing pits and fissures, thereby preventing caries (Pizzo, 2007).

## 5 CONCLUSION

As one of the most common diseases in daily life, caries is harmful and poor. How to reducing the incidence of dental caries and how to deal with the impact of dental caries are the direction that needs to be worked hard at this stage. This article mainly introduces caries, pathogenesis, preventive measures, and corresponding treatment methods at various levels.

Although with the development of medical technology, there are more and more kinds of materials for the treatment of caries. However, the clinical treatment of caries is still unable to effectively control and treat it in the early stage of onset. Therefore, researchers still need to deepen further the treatment research on the treatment of dental caries. At the same time, the safety and promotion of dental caries products still require joint supervision and efforts from all walks of life. At present, more and more social groups are beginning to pay attention to oral hygiene and oral health, which is conducive to the development of dental caries prevention activities in society to promote oral health to all walks of life. In addition, the prevalence of dental caries varies from country to country. Compared with developed countries, developing countries have the most prominent caries problems. The government can formulate relevant policies or measures to reduce the risk of caries in the country, thereby promoting the development of caries prevention in the country.

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