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## Salivary pH and plaque index as risk factors of gingivitis in down syndrome children

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### Abstract

**Background:** Down syndrome is often found to have periodontal disease as a result of poor oral hygiene, accumulation of dental plaque, debris, and calculus. Down syndrome is often found to have problems with periodontal disease, especially gingivitis (47.2% of mild gingivitis, 40.8% of moderate gingivitis, and 8.6% of severe gingivitis). The severity of gingivitis is caused by the presence of plaque deposits, plaque growth is related to the quality and quantity of saliva.

**Purpose:** the purpose of this study was to determine the relationship between salivary pH and plaque index as a risk factor for gingivitis in children with Down syndrome.

**Method:** quantitative research with cross sectional research design. The sample in this study were children with down syndrome in SLB BC in Surabaya, with total 62 children with down syndrome. The sampling technique of this research is purposive sampling. Data analysis was performed using multiple linear regression test.

**Result:** There is significant effect between the pH of saliva and plaque index on the gingival index in children with down syndrome, which is 0.000. Strong predictors that affect gingivitis in children with down syndrome are salivary pH and plaque index (R=0.604)

**Conclusion:** the salivary pH value and plaque index have a significant effect on gingivitis in children with down syndrome.

**Keywords:** down syndrome, gingivitis, plaque index, salivary pH

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### Introduction

Down syndrome is an inherited disease characterized by chromosomal abnormalities in humans and typically underlies some degree of knowledge weakness and certain types of somatic traits. Population down syndrome occurs between 1 in 400-1500 babies born in different populations [1]. Down syndrome is an intellectual disability caused by genetic factors [2]. Recent studies have shown that the prevalence of down syndrome is 8.72 per 10,000 population each year [3,4]. Riskesdas reports that in 2013, the prevalence of Indonesian children aged 24-59 months with disabilities, including Down syndrome, was 0.13% [5].

Down syndrome has specific oro-facial characteristics that can increase the risk of oral health problems [2]. Children with Down syndrome cannot perform oral and dental hygiene independently because they have problems such as limitations in cognitive and motor development. Children with Down syndrome are often found to have periodontal disease as a result of poor oral hygiene, accumulation of dental plaque, debris, and [6]. On the other hand, people with Down syndrome develop a more severe form of the disease compared to the general population, they mostly experience gingivitis or bacterial gingivitis which is marked in red [7]. Likewise children with intellectual disabilities have a gingivitis prevalence of more than 50%, namely 69% [8]. Down syndrome is often found to have problems with periodontal disease, especially gingivitis (47.2 mild gingivitis, 40.8% moderate gingivitis, and 8.6% suffering from severe gingivitis) [9]. Reuland-Bosma W and Van Dijk J stated that around 14-100% of Down syndrome patients aged less than 30 years had gingivitis [10]. Several literature studies say that Down syndrome often has the highest prevalence of gingivitis, gingival recession, periodontal disease, and deep pockets. This shows the seriousness of dental and oral diseases that often occur in children with down syndrome as a result of poor oral hygiene [11].

Good oral hygiene is an important factor in getting optimal dental and oral health conditions. Poor oral hygiene is characterized by plaque and calculus deposits that can cause periodontal disease [10]. Periodontal diseases such as gingivitis that are not treated will cause periodontitis which can later cause the teeth to fall out of their sockets [12]. Gerret et al's study showed a plaque index of 1.33 and a gingival index of 1.67 in mentally retarded children in Polonia. One of the high indexes is due to the level of poor oral hygiene and the high prevalence of periodontal disease among other disabled individuals [13]. The severity of gingivitis is caused by the presence of plaque deposits on the tooth surface. Plaque on teeth consisting of bacterial accumulation is the main etiology of gingivitis which is the initial stage of damage to the periodontal tissue [14].

The growth of plaque is related to the quality and quantity of saliva. Ratnasari's study on girls aged 7-10 years and still in the treatment phase of pulmonary tuberculosis experienced a decrease in the salivary flow rate followed by an increase in the rate of plaque growth [15]. The degree of acidity of saliva under normal conditions is between 5.6-7.0 with an average pH of 6.7. Several factors that cause changes in salivary pH include the

average salivary flow rate, oral microorganisms, and the buffering capacity of saliva. The optimum salivary acidity (pH) for bacterial growth is 6.5–7.5 and if the oral cavity has a low pH between 4.5–5.5, it will facilitate the growth of acidogenic bacteria such as *Streptococcus mutans* and *Lactobacillus* [16]. The degree of acidity (pH) of saliva is one of the important factors that play a role in dental caries, periodontal disorders, and other diseases in the oral cavity. The normal level of acidity (pH) of saliva in the mouth is at number 7 and if the pH value of saliva falls 5.5, it means the situation is very critical. The pH value of saliva is inversely proportional, where the lower the pH value, the more acid in the solution. On the other hand, increasing the pH value means increasing the base in the solution. At pH 7, there is no acidity or alkalinity of the solution, and it is called neutral [17]. Based on the existing phenomena and supported by research results, the researchers were interested in getting concrete data about salivary pH and plaque index as risk factors for gingivitis in children with Down syndrome. Based on the explanation above, the purpose from this research is to know the effect of salivary pH and plaque index as risk factors for gingivitis in children with Down syndrome.

### Materials and Methods

This research was an observational analytic with a cross sectional research design. The population in this study were children with Down syndrome in Surabaya city with 62 respondents. The sampling technique was carried out by purposive sampling. This study used observation through examination of the oral cavity to measure salivary pH, plaque index and gingival index in children with Down syndrome. Measurement of salivary pH in normal conditions ranges from 6.8 - 7.2, while the degree of acidity of saliva was determined to be low if it was between 5.2 - 5.5 under conditions of low salivary pH. The examination was carried out on the facial or lingual dental crowns by dividing each crown surface into five subdivisions, namely D (distal), G (gingival middle third), M (mesial), C (middle third, incisal or occlusal middle third). Plaque assessment, presence of plaque = 1 no plaque = 0. Gingivitis index of children with Down syndrome. Mild inflammation: 0.1-1.0. Moderate inflammation: 1.1 -2. Severe inflammation: 2, 1-3.0.

The location of this research was conducted in special schools in the city of Surabaya. The time of the study was carried out from August-October 2021. This research has passed an ethical approval which was approved by the Health Research Ethics Commission of the Health Polytechnic of the Ministry of Health Surabaya ethical number: No.EA/688/KEPK-Poltekkes\_Sby/V/2021. Data processing was analysed using statistical analysis, namely proportion or percentage analysis by comparing cross tabulations between two variables and correlation test to see the relationship between three variables, using multiple linear regression test.

### Results

**Table 1:** Frequency distribution of down syndrome characteristic

Characteristic	N	Percentage (%)
Age		
8 years	6	9,7%
9 years	4	6,5%
10 years	9	14,5%
11 years	3	4,8%
12 years	4	6,5%
13 years	5	8,1%
14 years	12	19,4%
15 years	7	11,3%
16 years	4	6,5%
17 years	3	4,8%
18 years	4	6,5%
21 years	1	1,6%
Total	62	100%
Gender		
Female	27	43,5%
Male	35	56,5%
Total	62	100%

Based on table 1, it was shown that in this research the most age of children with down syndrome are in 14 years (19,4%) and in 10 years (14,5%). The dominant gender of this research sample was male (56,5%).

**Table 2:** The result of regression test analysis statistic

Variable	N	p-Value	Coefficient of Regression
Plaque Index	62	0.000*	0.604
Salivary pH	62		

Table 2 shows that there was a significant effect (p-value 0.05) between salivary pH and plaque index on the risk of gingivitis in children with down syndrome. The results of data analysis using multiple linear regression showed a strong relationship between salivary pH and plaque index on gingivitis in children with down syndrome ( $R=0.604$ ). This coefficient showed a positive effect, which means that the higher the plaque index and salivary pH can increase the severity of gingivitis. Based on this analysis, plaque index and salivary pH had a strong influence on gingivitis in children with down syndrome.

## Discussion

Saliva is a complex oral fluid consisting of a mixture of secretions from large and small salivary glands present in the oral mucosa. Saliva has a very important role in regulating oral homeostasis<sup>[18]</sup>. This fluid comes from the major and minor salivary glands. Required in sufficient quantities in the mouth, if the lack of saliva will create a high amount of plaque in the mouth. Saliva is considered the most important natural defense against dental caries and oral diseases<sup>[19]</sup>. The more acidic the salivary pH, the easier it is for dental caries to occur. Salivary pH, viscosity, buffer capacity and composition also play a role in dental caries and periodontal disease. For 24 hours, the saliva secreted by the three glands is 1000-2500 ml. At night, there is less salivation<sup>[20]</sup>.

The pH of saliva in children with Down syndrome in this study described the pH range of 5-9. This shows that the salivary pH of children with Down syndrome is both acidic and alkaline. At an alkaline salivary pH, saliva secretion occurs in children which is quite high, so that it has an impact on high saliva volume as well. Research from Akhmad *et al.* showed that the pH of saliva was around 7.24 with a standard deviation of 0.27<sup>[18]</sup>. In a study showed the salivary pH of children with Down syndrome ranging from 6.7 to 6.9. The condition of the salivary pH of children with Down syndrome in this study also affects the gingivitis of children with Down syndrome<sup>[21]</sup>.

The gingivitis condition in children with Down syndrome had the lowest score of 0.17 and the highest score of 2.33. When viewed from the degree of gingivitis children with Down syndrome are included in the moderate category. In this study, the majority of Down syndrome children experienced gingivitis. Similar to research from Amira *et al.*, 96.6% of Down syndrome children have gingivitis. Gingivitis is an inflammation of the gingival, the junctional epithelium is still intact attached to the tooth in its initial condition so that the attachment has not changed. If the inflammatory discharge has involved the gingiva and other periodontal tissues and there has been a detachment of the periodontal fibers, it is termed periodontitis<sup>[6]</sup>.

Gingivitis is caused by the accumulation of dental plaque and calculus. In addition, the incidence of gingivitis is supported by local factors such as oral hygiene, dental composition, oral breathing habits, salivary pH, iatrogenic dentistry, tissue trauma, and the physical nature of eating. There are also systemic factors such as smoking habits, nutrition, hormones, stress and drug use. In addition, socioeconomic conditions, oral hygiene maintenance factors and unmodified factors such as age, gender and genetics<sup>[22]</sup>.

The results of this study indicate that there is a significant effect of salivary pH on gingivitis in children with Down syndrome. The condition of gingivitis in children with Down syndrome is directly proportional to the pH of the saliva. The more gingivitis of children with Down syndrome, the salivary pH of children with Down syndrome is more acidic. However, in the study there were conditions that showed alkaline salivary pH even though the oral cavity of children with Down syndrome showed a severe degree of gingivitis. This is triggered by hypersaliva in children with Down syndrome. A study showed salivary pH in alkaline conditions also has the potential for gingivitis<sup>[23]</sup>. Research from Sharma *et al.*, 2012 says there is a positive correlation (+0.045) between pH and gingival scores in school children 12-15 years in Rural and Urban Jaipur City. Another study said that salivary pH had no effect on the incidence of gingivitis<sup>[24]</sup>.

Dental plaque consists mostly of water and various kinds of microorganisms that proliferate in an intercellular matrix consisting of extracellular polysaccharides and salivary proteins. About 80% of the weight of the hold is water, while the number of microorganisms is approximately 250 million per mg wet weight. In addition, plaque contains loose epithelial cells, leukocytes, particles of food residue, inorganic salts consisting mainly of calcium, phosphate, and fluorine. Anandya *et al's* research on children with mental retardation had a bad plaque index, as many as 3 children with mild mental retardation (13.63%) with a good plaque index and 19 children (86.67%) with a bad plaque index, children with moderate mental retardation showed 1 child (4.7%) with good plaque index, and 20 children (95.23%) with poor plaque index, and severe mental retardation showed 100% or 2 children with poor plaque index. The majority of mentally retarded children in the study showed high scores. Mentally retarded are basically divided into Down syndrome and non-down syndrome<sup>[13]</sup>.

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diseases such as gingivitis that are not treated will cause periodontitis which can later cause the teeth to fall out of their sockets <sup>[12]</sup>.

People with Down syndrome are a high-risk group for health problems including dental and oral health. The group studied showed that there were more boys with Down syndrome than girls. This study shows that salivary pH and plaque index as strong predictors in influencing the occurrence of gingivitis in children with Down syndrome. This study is in line with the results of the study of Hamala *et al.* demonstrated that saliva and plaque index determine gingival status in children. Recently, many researchers have concentrated on the examination of saliva because it reflects the many different conditions of the oral and body cavities. In addition, technological developments in the field of medicine provide many opportunities to carry out different research on microorganisms and saliva <sup>[25]</sup>. Another study said that the plaque index and gingivitis severity of mentally retarded children in SLB X Bandung City, concluded that almost every type of mental retardation had a poor plaque index and oral gingivitis. Plaque causes pathological conditions in the oral cavity. Interpretation is sometimes difficult because of the influence of normal flora and interactions between bacteria that can increase cariogenic potential. The initiation process of gingivitis occurs when dental plaque accumulates for days or weeks without cleaning and removal, resulting in a loss of the symbiosis between the biofilm and the immune response. Further development is influenced by systemic factors, including endocrinopathy, haematological conditions, diet, and medications, which can modify the immune-inflammatory response <sup>[13]</sup>.

The salivary pH of children with Down syndrome is mostly acidic, some even show neutral and alkaline pH. An acidic pH condition is found if the oral cavity of a child with Down syndrome has a high plaque index value and gingivitis conditions. Of all respondents, only 2 had an alkaline pH followed by gingivitis and a high plaque index, but it was known that the child had hypersaliva. At an alkaline salivary pH, saliva secretion occurs in children which is quite high, so that it has an impact on a high saliva volume as well <sup>[27]</sup>. Conditions that can increase plaque retention are caused by many factors, one of which is saliva, where one of the functions of saliva is to regulate the pH of the oral cavity because it contains bicarbonate, phosphate and amphoteric protein. Saliva is a hypotonic solution of salivary acini, gingival crevicular fluid and oral mucosal exudates. High-permeability salivary glands are surrounded by many capillaries, blood and acini, and can exchange molecules. Therefore, biomarkers in circulating blood can infiltrate the acini and eventually be secreted into saliva. The characteristics of saliva are colorless, odorless and have a relative density of 1.004–1.009 and a pH of 6.6–7.1. Inflammatory markers in saliva are important in determining the presence, risk, and phase transition between healthy gingiva and gingivitis. A recent study showed a positive correlation between salivary unstimulating superoxide levels and clinical symptoms such as gingival index, pocket depth and clinical attachment loss in patients with chronic periodontitis.

## Conclusion

Salivary pH and plaque index affects gingivitis in children with down syndrome. This condition occurs because saliva pH and plaque index are strong predictors of the occurrence of gingivitis in children with down syndrome.

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