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Comparison of Caries Status and Saliva Condition (pH, Buffer Capacity, Flow Rate, and Volume) among Down Syndrome and Normal Children aged 6-18 Years Old in SLB C Medan Helvetia and Medan Timur District

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***Abstract*–Down Syndrome (DS) is type of mental disability caused by genetic disorder in chromosome 21. DS causes inability to maintain oral hygiene thus dental caries are commonly found in children with DS. Purpose of this research is to study the difference between caries experience and saliva condition and determine the relationship between caries experience with saliva condition in DS and normal children aged 6-18 years old in Medan Helvetia and Medan Timur district. This research was conducted in observational analytic manner with cross sectional design. Subjects were 30 DS and 30 normal children aged 6-18 years old in Medan Helvetia and Medan Timur district. Data collection was done using clinical examination based on deft/DMFT index by WHO and saliva examination using GC Saliva Check Buffer Kit. Statistical analysis showed that there were no significant differences in deft between DS and normal children, and there was a significant difference in DMFT in DS and normal children. Statistical analysis also showed significant difference in saliva condition (pH, buffer capacity, flow rate, and volume), and there was significant relationship between caries experience (deft/DMFT) with saliva condition in DS and normal children aged 6-18 years old in Medan Helvetia and Medan Timur district. Deft caries experience in DS children is almost similar as in normal children, while DMFT caries experience in DS children is higher than normal. Result showed that saliva condition in DS is lower than in normal children. Saliva condition can affect caries experience in DS and normal children.**

Keywords–caries, Down syndrome, salivary flow rate

I. INTRODUCTION

Dental and oral health is part of general health that affects children's quality of life [1]. Problems that often occurs in children's oral cavity is caries. Caries is a disease that affects hard tissues in oral cavity caused by microorganisms' activity [2]. Caries process requires the interaction of four factors, which are host, microorganism, substrate, and time. The presence of substrates attached to teeth will nourish the bacteria in oral cavity so that the bacteria will produce acid that leads to demineralization of the teeth.

Salivary flow rate, volume, buffer capacity, and pH are also conditions that can affect the development or inhibition of caries process [1]. Low salivary flow rate and volume will cause difficulty in eliminating the food debris, thus accelerating caries process. High salivary flow rate and volume will protect teeth optimally from bacteria thus reducing dental caries. High salivary buffer capacity play role in maintain the pH from reaching critical point that can dissolve the enamel. Low buffer capacity will increase the acidic condition and leads to colonization of bacteria causing caries.

Dental caries is an oral cavity problem with the highest prevalence in the world. According to the SEARO (South East Asia Region) data, 70-95% of school-aged children in Southeast Asia suffer from caries [3]. Caries can occur in both normal and mental retardation children. An epidemiological survey of 472 normal children aged 7-14 years in India showed a fairly high caries prevalence, which was 80.92%. Results obtained showed that the mean DMFT scores at aged 7-10 and 11-14 years were 4.47 and 2.66 [4]. Several research also showed a high prevalence of caries in children with Down syndrome. Study of Achmad et al in Makassar showed that the prevalence of dental caries in Down Syndrome children is quite high, which was 82,6% with mean DMFT score 3.69. Normastura et al stated that caries problem in DS children increase with

age. This statement is supported by research conducted by Al-Khadra on 224 DS children in Riyadh that showed the average deft and DMFT score in children aged 7-14 years was 6.09 ± 2.34 and 3.93 ± 1.64 while at aged 15-22 years, the average deft and DMFT score is 1.53 ± 0.54 and 4.11 ± 1.77. Other studies also showed that caries in DS children was usually low due to changes in teeth' shape and time of eruption. According to research conducted by El Yazeed et al, 30 DS children aged 8-14 years in Egypt had low average DMFT score which was 0.35 ± 0.7. Radhi et al believes that caries experience of DS children is lower than normal children.

Children with Down Syndrome often experience drooling, which is a continuous salivary excretion caused by muscle hypotonus and hypersalivation [5]. According to Achmad et al, hypersalivation state in DS children causes decreasing in caries risk [6]. DS children also undergo physiological changes in salivary composition and flow rate, thus affecting the incidence of caries [7]. Research conducted by El Yazeed et al in Egypt stated that the IgA level was higher in DS children' saliva compared with normal children [8]. Immunoglobulin A (IgA) is one of body's defense system in facing pathogen microorganism [9]. Normastura et al study on 60 DS children in Malaysia showed low unstimulated salivary flow rate [10]. Castilho et al found that 44% of DS children had low buffer capacity. Research conducted by Pandey et al in 7-15 year old children in India showed that the average salivary flow rate and buffer capacity were still within normal limits. According to Winer and Feller, salivary buffer capacity in DS was higher than normal, but the salivary flow rate was lower than normal children. According to Radhi et al, there was a relationship between pH, buffer capacity, and salivary flow rate with caries status in normal and Down Syndrome children ($p < 0.001$).

II. MATERIALS AND METHODS

This research was an observational analytic research with cross sectional design. Sampling for children with Down Syndrome was taken using total sampling method, while normal children was taken using matching method by adjusting the child age and gender, and if the normal children sample was more than DS children, then random sampling method is used. The population in this study were 30 Down Syndrome children and 30 normal children aged 6-18 years old in Medan Helvetia and Medan Timur district. Data collection was done using clinical examination of the child's teeth based on deft/DMFT index by WHO and saliva examination using GC Saliva Check Buffer Kit.

Examination was conducted between 9-11 am in the room with adequate lighting. Unstimulated saliva was obtained by instructing the respondents to sit in an upright position with their heads slightly bent for collecting the saliva. Saliva collection was done in saliva collection cup by drooling method for 5 minutes. Obtained saliva was then measured in volume and recorded in millimeters.

Measurement of salivary flow rate was done by dividing total volume collected with total time used for collecting (5 minutes). Saliva flow rate results will be in ml/min.

The pH strip is immersed in saliva for 10 seconds, then removed. The pH strip is then compared with pH indicator paper on GC Saliva Check Buffer Kit. The pH score calculation should be done immediately before pH strip dried as this will affect the visual interpretation of the paper color.

Measurement of salivary buffer capacity was done by taking saliva with a pipette then dripped on strip buffer, each 1 drop for 1 pad column on strip test. After 2 minutes, the color changes on the buffer strips is then compared with the buffer capacity indicator on GC Saliva Check Buffer Kit and the score of each pad on the buffer strip is summed to get the category.

After salivary examination, dental examination is performed using explorer, mouth mirror, and excavator. The child's head position was half looked up and the child was asked to open his mouth. The examination is performed from distal part of molar teeth from patient' upper right region using explorer and mouth mirror. If the tooth has caries, then the tooth is cleaned and then dried by using cotton. The missing teeth in child need to be checked for the exact cause. Congenital loss of the teeth, missing teeth due to date, missing teeth post-trauma, missing teeth for orthodontic treatment is not included in caries index calculation. The research procedure in DS children should be done under parental supervision. Caries, filling, and extractions are recorded and added in the provided form.

Unpaired T test (T independent test) was used to determine the differences of caries experience and salivary conditions in Down Syndrome children and normal children. Chi square test was used to determine the relationship between caries experience with salivary conditions in Down Syndrome children and normal children.

III. RESULTS

Table I showed the characteristics of respondents include gender and dentition period. Based on sex, boys and girls with DS and normal children had the same percentage, which was 56.7% and 43.3% respectively. Based on the dentition period in DS, the percentage of children in mixed dentition period was 60% and in permanent dentition period was 40%. In normal children, the percentage of children in mixed and permanent dentition was 50%.

TABLE I. RESPONDENTS CHARACTERISTIC IN DOWN SYNDROME AND NORMAL CHILDREN

Characteristic	**Down Syndrome (n=30)**		**Normal (n=30)**		**Total (n=60)**	
	n	***%***	***n***	***%***	***n***	***%***
Gender						
Male	17	56.7	17	56.7	34	56.7
Female	13	43.3	13	43.3	26	43.3
Dentition period						
Mixed	18	60	15	50	33	55
Permanent	12	40	15	50	27	45

Table II showed respondents characteristic based on age, where most of DS and normal children aged 9 years old, which was 9 children (30%), while the least aged was 13 years, which was one child (3.3%).

TABLE II. RESPONDENTS CHARACTERISTIC BASED ON AGE

Age	Down Syndrome (n=30)		Normal (n=30)		Total (n=60)	
	n	*%*	*n*	*%*	*n*	*%*
8	4	13.3	4	13.3	8	13.3
9	9	30	9	30	18	30
10	2	6.7	2	6.7	4	6.7
12	3	10	3	10	6	10
13	1	3.3	1	3,3	2	3.3
14	4	13.3	4	13.3	8	13.3
15	3	10	3	10	6	10
16	2	6.7	2	6.7	4	6.7
17	2	6.7	2	6.7	4	6.7

Unpaired T test is used to obtain the difference of mean caries experience in DS and normal children. Statistical analysis result showed that there was no significance difference in mean of deft caries experience (p=0.955) and there was a significance difference in mean of DMFT caries experience in DS and normal children (p=0.043) (Table III).

TABLE III. DIFFERENCE CARIES EXPERIENCE IN DOWN SYNDROME AND NORMAL CHILDREN

Caries experience	Down Syndrome (n=30)	Normal (n=30)	p
Deft	2.55 ± 2.40	2.60 ± 2.02	0.955
DMFT	3.40 ± 2.29	2.20 ± 2.18	0.043

Unpaired T test is used to obtain the difference of mean salivary condition in DS and normal children. Based on salivary condition examination, there was a significance difference between pH, buffer capacity, flow rate, and volume in DS and normal children (Table IV).

TABLE IV. DIFFERENCE SALIVARY CONDITION IN DS AND NORMAL CHILDREN

Salivary condition	Down Syndrome (n=30)	Normal (n=30)	p
pH	6.53±0.69	6.98±0.65	0.013
Buffer capacity	7.96±3.07	9.53±2.84	0.045
Flow rate	0.35 ± 0.13	0.47 ± 0.17	0.004
Volume	1.75 ± 0.69	2.35 ± 0.85	0.004

Chi square test is used to obtain the relationship between caries experience (deft/DMFT) with salivary condition (pH, buffer capacity, flow rate, and volume) in DS and normal children. Saliva examination in DS children showed that there was a significance relationship between caries experience with salivary condition (p<0.05) (Table V).

TABLE V. RELATIONSHIP BETWEEN CARIES EXPERIENCE (DEFT/DMFT) WITH SALIVARY CONDITION (PH, BUFFER CAPACITY, FLOW RATE, AND VOLUME) IN DS CHILDREN

Salivary condition	deft (x ± SD)	p	DMFT (x±SD)	P
pH				
Normal	0.50±0,83	0.000	1.90±0.99	0.000
Acidid	2.33±1.32		3.73±2.05	
Very acidic	6.66±1.15		5.40±3.20	
Buffer capacity				
Normal	1.00±1.00	0.000	1.90±0.94	0.000
Low	2.42±1.51		4.00±2.08	
Very low	5.00±3.46		4.83±3.18	
Flow rate				
Normal	1.71±1.43	0.002	3.08±1.90	0.004
Low	5.00±3.46		4.66±3.38	
Volume				
Normal	1.71±1.43	0.002	3.08±1.90	0.004
Low	5.00±3.46		4.66±3.38	

Based on salivary condition in normal children, there was a significant relationship between caries experience and saliva condition (pH, buffer capacity, flow rate, and volume) (p<0.05) (Table VI).

TABLE VI. RELATIONSHIP BETWEEN CARIES EXPERIENCE (DEFT/DMFT) WITH SALIVARY CONDITION (PH, BUFFER CAPACITY, FLOW RATE, AND VOLUME) IN NORMAL CHILDREN

Salivary condition	deft	p	DMFT	P
pH				
Normal	1.27±1.27	0.004	0.63±0.80	0.000
Acidic	2.50±0.70		3.50±0.70	
Very acidic	6.50±0.70		6.00±1.41	
Buffer capacity				
Normal	1.27±1.27	0.004	0.63±0.80	0.000
Acidic	2.50±0.70		3.50±0.70	
Very acidic	6.50±0.70		6.00±1.41	
Flow rate				
Normal	1.53±1.33	0.001	1.07±1.32	0.028
Low	6.50±0.70		6.00±1.41	
Volume				
Normal	1.53±1.33	0.001	1,07±1,32	0.028
Low	6.50±0.70		6,00±1,41	

Table VII showed the caries status percentage in Down syndrome and normal children.

TABLE VII. CARIES STATUS PERCENTAGE BASED ON GENDER IN DS AND NORMAL CHILDREN

Group	n	Deft caries status						DMFT caries status					
		low		moderate		high		low		moderate		high	
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Down Syndrome													
Mixed	18	11	61	4	22	3	17	11	61	4	22	3	17
Permanent	12							3	25	6	50	3	25
Normal													
Mixed	15	9	60	4	27	2	13	11	73	2	13	2	13
Permanent	15							7	46	5	33	3	20

IV. DISCUSSION

Caries is an oral health problem that has an effect on child' general health, either in both normal and special needs child such as Down syndrome. This study was conducted on 30 Down syndrome and 30 normal children with the percentage of boys 56.7% and girls 43.3%. Percentage of mixed dentition period in DS

children was 60% while permanent dentition was 40%. Percentage of mixed and permanent dentition in normal child was 50%. Statistical analysis showed that there was a significant difference in the DMFT caries experience in DS and normal children (p=0.043). Statistical analysis also found that there was no significant difference in caries experience in Down Syndrome and normal children (p=0.955). This is consistent with the research of El Yazeed et al and Raurale et al who found that there was a significant difference in the DMFT caries experience of Down syndrome children and normal children [8,11]. Results of this study showed that the average deft caries experience in Down Syndrome children was similar to normal children, but average DMFT caries experience in Down Syndrome was higher than in normal children. This is in accordance with Normastura et al in Malaysia that the average deft caries experience in DS children is almost the same as normal children whereas the average DMFT caries experience in DS children is higher than normal children [10].

DMFT caries experience was higher because DS children have limitations in maintaining oral hygiene and diet and also lack of attention from their parents to the child mouth and teeth problem. Children with DS also have limitations in communicating so they can't provide information to parents when experiencing toothache [6]. According to Crowley et al, one of the factors that play role in severity of caries possessed by mental retardation children is intellectual degradation and motoric limitations factors. This low intellectual degradation and motoric limitations cause the memory and capture power and applicative ability of the child's mental retardation to decrease so that the child often forget and difficult to clean his teeth. Mental retardation children also require repetitive teaching to understand the ways and the importance of oral health [11]. A similar mean deft caries experience may be due to role of parents in maintaining oral health in DS or normal children in younger age. Other than that, this also can happened because of uneven sample distribution according to age, so that there was greater child with missing deciduous teeth. According to Liu et al, oral health in special needs children can be increased to be similar or better than normal children of the same age because of daily tooth-brushing practices done with parents or dietary controls by schools resulting in a small caries experience [13].

The results of this study was different from El Yazeed et al in Egypt which found that the DMFT caries experience in DS children was lower than normal children. El Yazeed et al found that lower caries experience in DS was due to elevated Immunoglobulin A, calcium, phosphorus and fluoride level in child's saliva [8]. Other studies also suggest that lower caries experience in DS is due to delayed tooth eruption, dental malformation, congenital tooth loss, and different salivary composition [8,14].

Based on statistical analysis, there was significant differences in salivary condition in DS and normal children in Medan Helvetia and Medan Timur district. The results showed a significant difference in DS and normal children' pH (p=0.013). Radhi et al found that there was no significant difference in DS and normal children' pH [15]. Raurale et al found that there was a significant difference in DS and normal children' pH. According to the results of this study, pH levels in children with Down syndrome were lower than in normal children [11]. These results are consistent with studies conducted by Normastura et al, but contrary to the results of studies conducted by Radhi et al and Raurale et al found that pH levels in DS children was higher than normal children. Differences in this outcomes can be due to unstimulated saliva used in this study, while Radhi et al used stimulated saliva. Winner et al believes that stimulated saliva in DS children has higher pH than normal children [14]. This can also be due to differences in the number of samples and tools used. Radhi et al used pH meter with 50 DS and 50 normal children as sample.

Statistical analysis showed that there was a significant difference in the buffer capacity in DS and normal children (p=0.045). Raurale et al and Radhi et al found that there was a significant difference in the buffer capacity in DS and normal children [11,15]. According to this study, buffer capacity in DS children was lower than in normal children. This results contradicted with Radhi et al and Raurale et al whose found that buffer capacity in DS children was higher than in normal children [15]. This difference outcome was probably due to this study using unstimulated saliva while Radhi et al used stimulated saliva. Bicarbonate concentration 1 mmol/L was in unstimulated state and will increase to 50 mmol/L when stimulated. Saliva in stimulated state is produced by parotid gland. Parotid gland has high bicarbonate levels so that the buffer capacity will be higher [16].

Statistical analysis showed that there was a significant difference in flow rate and volume in DS and normal children (p=0,004). Radhi et al and Raurale et al also found that there was a significant difference in flow rate in DS and normal children [11,15]. According to the results of this study, the flow rate and volume in DS children was lower than normal. Results of this study were in accordance with Radhi et al, Normastura et al, Raurale et al, and Castilho et al. According to Radhi et al, low salivary flow rate in DS children was caused by genetic parotid gland abnormalities [15]. Generally, mental retardation children had genetic disorder that affects the intelligence and brain neural that also allow the abnormalities in sympathetic and parasympathetic nerve that may affect the balance of saliva secretion. Several studies also found that parotid glands' aplasia was often found in DS children [13,17]. Results of this study do not match with Cheng et al that states drooling in DS children is caused by hypersalivation [5]. According Suharsini, drooling conditions in DS children is caused by hypotonus of facial muscle [18].

Statistical analysis showed that there was a significant correlation between salivary pH and

deft/DMFT caries experience in DS children (p=0.000). According to this study, mean of salivary pH in DS children was in acidic category. The acidic condition may be a contributing factor in high caries experience in DS children. Based on statistical analysis, there was a significant correlation between salivary buffer capacity with deft/DMFT caries experience in children with DS (p=0.000). Mean buffer capacity in DS children is included in low category. Low salivary buffer capacity will cause the oral cavity to become more acidic and lead to colonization of carious bacteria in DS children. Results of this study were in accordance with El Yazeed et al that stated there was significant relationship between salivary pH and DMFT caries experience in DS children (p=0.001) [8]. Results of this study didn't match with Castilho et al that stated there was significant relationship between salivary buffer capacity and the caries experience in DS children [19]. This difference may be due to differences in the tools used. Castilho et al used pH paper to calculate the pH and buffer capacity. In addition, the difference can also be caused unstimulated saliva used in this study while Castilho et al used stimulated saliva.

Based on statistical analysis, there was significant correlation between salivary flow rate and salivary volume with deft/DMFT caries experience in DS children (p=0.002) (p=0.004). The average volume and salivary flow rate in DS children was included in normal category. Volume and flow rate play role in cleaning food debris so that it can reduce the occurrence of caries process. This result is in contrast with Castilho et al that stated there was no significant relationship between deft/DMFT caries experience with flow rate in DS children.

Statistical analysis showed that there was a significant relationship between salivary pH and deft/DMFT caries experience in normal children (p=0.004) (p=0.000). The statistical results also showed that there was significant relationship between buffer capacity and deft/DMFT caries experience in normal children (p=0.004) (p=0.000). Results showed that pH and buffer capacity in normal children were included in the normal category so that caries experience was low. According to Zahawi's research on 600 normal children aged 6-16 in Erbil showed that there was significant relationship between DMFT caries experience with salivary pH. Zahawi also found that there wasn't any significant relationship between buffer capacity and DMFT caries experience in normal children [20]. Differences in results may be due to differences in the number of samples and tools used. Zahawi used CRT Buffer to calculate buffer capacity with a sample size of 600 normal children.

Based on statistical analysis, there was significant correlation between salivary flow rate with caries experience in normal children (p=0.001) (p=0.028). Statistical results also showed that there was a significant correlation between salivary volume with caries experience in normal children (p=0.001) (p=0.028). The results showed that the average flow rate and volume in normal children were in normal category. According to Zahawi, there is a correlation between the flow rate with DMFT caries experience in normal children [20]. This result is consistent with theory that stated small salivary gland secretion causes children to be susceptible to caries due to decreased salivary volume in children followed by decreased of mechanical cleansing that will lead to demineralization.

Results of the study also found that the percentage of DMFT in mixed dentition period in DS children was mostly included in low category that is equal to 61%. The percentage of DMFT in permanent dentition was included in moderate category, which was 50%. These results indicated that DMFT caries experience were low in the mixed and permanent dentition in DS children. The high experience of DMFT caries in permanent dentition is related to the duration of permanent teeth exposed to caries factors.

Results of this study found that the mean deft and DMFT caries experience in normal children were included in low category. The low caries experience can be caused by high awareness of normal children in maintaining their oral health. Based on the results in this study, the percentage of DMFT on mixed and permanent dentition was mostly in low category, which were 73% and 46% respectively. This indicated that DMFT caries experience in the medium and high category are more common in normal children in the permanent dentition. The high experience of DMFT caries in the permanent dentition is related to the duration of permanent teeth exposed to caries factors.

This result is incompatible with Shingare et al that stated in mixed dentition period, DMFT caries experience was higher because of the anatomy of the tooth that had not been fully calcified and therefore more susceptible to caries [4].

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